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Electric Railway Development. THE news which we published two weeks ago as to the arrangement arrived at by the Thomson-Houston and Van Depoele companies as to electric railway work is now authoritatively confirmed. As we then said, it must be evident to all that the activity of the Thomson-Houston Company in this department will give it a great impetus. The friends of Mr. C. J. Van Depoele will be glad to know that he will have charge of the work under the new condition of affairs. The Van Depoele Company will confine its attention to the lighting field.

Calculating Transformers. As a continuation of the work presented by Mr. G. Kapp on the method of designing transformers, the paper printed in our last issue is a valuable addition to the literature of the subject. Mr. Kapp has essentially followed a theory similar to that brought into practice in his method of dynamo design and the results obtained seem to agree well with actual previous practice. In the course of the investigation it is shown that in order to avoid danger of, and loss by, heating in the iron core and the disagreeable musical sound sometimes emitted by the converter, the iron must not be carried to very high degrees of magnetization. Or, in other words, a converter containing a given weight of iron must, for continuous work, be driven below its full capacity, especially if good regulation is desired. This, of course, means no loss in efficiency in the converter, but is merely a question of weight. In this respect the problem is quite similar to that involved in designing dynamos where the question of regulation and efficiency at all loads is considerably influenced by the relative weight of iron employed. An interesting fact developed by Mr. Kapp is that although considerable difference of effect is claimed for various types of transformers, theory shows that little difference can exist between them, due to the relative position of copper and iron, provided they are properly designed.

New Work in Telegraphy. OLD as the telegraph is, and vast as is the amount of thought that has been bestowed upon it, there are still not wanting those who seek to improve or modify present methods in that branch. One of the objections that has ever attached to receiving by sound is the lack of a permanent record either by the receiving or the sending station, and this is considered so great an objection in some countries as to maintain the Morse printer still in use. The objection which that meets here is the comparatively complicated character of the apparatus, and the attention which it requires, as compared with that of the simple sounder; but still the want of some record is not, therefore, entirely overcome. It is curious to note that, in order to obtain a ready record by simple means, an inventor has hit upon the idea of employing an ordinary writing pen to effect the transmission of the message, and afford a record. At the same time that improvements are thus going on in one direction, the old methods are by no means discarded, and the familiar way of transmitting by means of the key and the lever will probably continue to hold their own for a long time to come. Hence it is interesting to note that the position of the telegraphist's hand while at work is a matter upon which there seems to have been considerable doubt, and as those the most expert in the work are the best judges of the method to be employed, the illustration in another column will probably invite the attention of not a few.

Instrument Making in America. THERE was a time, not long ago, when all instruments of precision, of whatever character almost, were procured from abroad of necessity. This was especially the case with electrical instruments, and those who have had an opportunity of visiting physical laboratories in this country cannot fail to have noted the enormous preponderance of electrical apparatus of foreign make. But it can now be safely asserted that most important electrical instruments of precision are obtainable in this country made fully as well as, and in some cases better than, those made abroad. That we are able to produce such instruments is shown by the description of a number of them which appears in another column. Professor Anthony, it will be remembered, has experienced great difficulty in obtaining a resistance box of the proper precision from abroad, and at last determined to undertake the work of making such an instrument himself, with the results given in another column. Some of the instruments designed by Prof. Anthony involve the application of a Clark cell as the standard of comparison, and it might be well to direct future efforts to the necessity of devising a form of this cell which will be portable and not liable to variation. The standard cell is one of the most useful pieces of apparatus in any laboratory, but the difficulty of obtaining and making the same of uniform character certainly deserves the study of those who are able to undertake the work.

Blackening of Incandescent Lamps. THERE are few more important questions put before the manufacturer of incandescent lamps than the obtaining of long life without a blackening of the interior of the globes. The theory generally accepted presupposes, or rather demands, the existence of a high vacuum for the deposit of the carbon by "molecular bombardment." But a contributor in our columns last week finds the cause of blackening in a diametrically opposite direction, in that the external pressure forces air into the bulb, which air consumes the carbon and vaporizes it. We believe that this opinion has been held by others, but the explanation thereof is that the air enters at the joint between the glass and the platinum wire embedded in the same. Our contributor holds that the air enters through the pores of the glass itself when the latter becomes heated by the filament. In contravention of this, it might be well to recall the experiment of Professor Quincke, who for many years maintained a tube of glass exhausted of air, and who was unable to detect the slightest difference in its weight by the most delicate balance after all that time, thus demonstrating that no air had entered the tube. It might be just possible that the thickness of the glass experimented upon may have been such as to prevent the entrance of air in the case just cited, and it might be conceivable that with the extreme thinness of the glass employed in the manufacture of incandescent lamps, the action might be marked, after all. Hollow vessels of comparatively thick metal, when under pressure and heated, allow the passage of liquids through their pores, and the action in the case of the incandescent lamp might be explained on those grounds. It would be an interesting experiment to determine the relative increase or decrease of the air pressure in an incandescent lamp at the time of its manufacture and after it had been in use sufficient time to have become blackened.

The Weather and the Wires. ELSEWHERE in our columns will be found an article on the great storm of which we made brief mention as we went to press last week. The storm was one which those who went through it can never forget, and one whose damage it will still take many days to repair and remove. It goes without saying, that with winds so high and snow so heavy, the aerial wires suffered to an unparalleled extent, especially in New York, where every electric service using overhead wires was crippled, and where communication with the outside world was for a time practically suspended. The rapidity with which wires have been restored and pole lines again set up speaks volumes for the zeal and devotion of those engaged upon the work. And now that the storm has become matter of record and no longer hampers as it did the ordinary pursuits of social life and business, its various lessons are being studied and discussed. As we remarked last week, one effect of the blizzard has been to renew the agitation for underground wires, and to give force to the arguments for an underground road, one new plan for which, using electric motors, has been made public within the week. One suggestion that deserves consideration is that there should be cables laid along the Atlantic coast, so as to insure communication between the great cities when the land wires are down. Getting news here from Boston by way of England, over the Atlantic cables, is rather roundabout. Another interesting point brought out by the storm was the efficacy of the train telegraph system, which we hope, as a consequence, to see very generally adopted. It is to be desired that the weather observations could be made more exact, so that storms of this character may not come upon an unsuspecting public quite so suddenly. Mr. M. G. Watkins, in a recent article in the *Academy*, remarks: "Meteorology is certainly not at present an exact science, although its students hope it is always drawing nearer to it. The best prognostics are liable to disturbing influences, which have not been taken into account. Only a percentage of forecasts can reasonably be expected to turn out correct. A much larger percentage, however, when thus scientifically calculated, is claimed as correct by modern meteorologists than would be the case were the weather merely estimated empirically by rule of thumb. Natural aptitude and the experience of many years' study are still the qualifications of a successful forecaster." This is well put, and it seems to us that one way of getting better forecasts is to enlarge the area and increase the number of telegraphic reports. The money spent on the Signal Service will be recouped a thousand times over in the good done to sailors, farmers and others.

THE VERDICT IN FAVOR OF BELL.

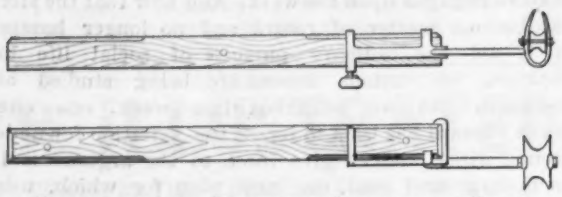
The end of all the tremendous litigation in which the Bell telephone patents have been involved appears to have been reached by the decision just rendered by the United States Supreme Court in favor of Prof. Bell. The court has passed in review the decisions given against the Dolbear, Drawbaugh, Clay, Molecular and Overland contestants, and has broadly sustained the patents on all the points in all the cases. While the court was not unanimous, the victory is a sweeping one, and it is hard to believe that any further attempts, even by Government, to break the patents, are likely, or will be made.

We have so often presented the merits of the various suits in these columns that to go into the matter again at any length would be waste of space, especially as the decision which we summarize on another page covers every one of the leading issues. The court finds that the Reis apparatus provided means for transmitting musical tones and nothing more, and in nowise affects the validity of the Bell patent. The court also held that Drawbaugh's claims to priority were unsustained. It was on this point that Judges Bradley, Field and Harlan dissented, being of opinion that Drawbaugh was the real first inventor of the telephone, whose value and importance he failed to realize. The court entered also into a consideration of the charges of bribery, collusion and fraud in the Patent Office, and expressed its conviction that there is no evidence whatever to tarnish the uprightness and integrity of Prof. Bell or his patent attorneys.

It cannot be said that this decision is unexpected. In fact, had the patents been broken there would have been general surprise, although many were prepared to see some limitation set upon the scope of the patent claims. The verdict is simply a repetition of the many that have already been given upholding the patents, and there were no new views of the case that the court could discuss or present. If ever a case had been well threshed before it came to final adjudication, it was that of the Bell patents, and the famous "fifth claim" stands as a striking example of the manner in which a great industry may be built upon and controlled by a good patent. However distasteful and disappointing the decision may be to some, it is not to be denied that every patent is to-day stronger and more valuable in light of the verdict supporting the telephone patents, as now rendered by the Supreme Court, and money will be the more readily forthcoming to develop new inventions and discoveries as the result.

Renewing Telegraph and Telephone Wires.

With the telegraph and telephone wires prostrated over a large section of the country, a device for facilitating repairs ought to be of special interest at this time. Such an one has recently been described by our English contemporaries, consisting of a tool designed by Mr. Dunn, engineer of the Caledonian Railway. The runner, as shown in the illustrations in plan and elevation, is attached to the arm by transverse jaws and an under pinching screw, and the outer end carries a free pulley, over which the new wire is run. The pulley is a special feature of the tool, as it offers little or no resistance to the wire, and in drawing out enables one man to do the work hitherto done by two. The "scouring" and "skinning" which take



FIGS. 1 AND 2.—RENEWING TELEGRAPH WIRES.

place when wire is drawn over rough ground, or over arms against insulator bolts or other rigid surfaces, are also completely obviated, and the wire is got into position without the zinc coating being broken or in any way impaired.

The method of using is as follows: One runner is attached to a long arm on each pole along the section over which a coil of new wire will run. The wire is then drawn out over the runners, and as those project it is kept clear of the standing wires on the poles. When drawn out, the wire is viced up on the runners and exchanged with the old wires, after which the latter is cut down. The whole process is gone through without the new or old wire getting foul of any other wire on the poles. It will be apparent that it is much easier to lift the bight of the wire on to the runners as it is being drawn out than to thread the wire over the arm between the insulator and the pole, as is done under the old system.

A number of appliances had been designed and tested by Mr. Dunn, but it was found after considerable experience that the one described is most suitable for the work. The advantages claimed are that it is light and portable, and can be quickly and securely attached without boring or cutting the arm. It provides complete immunity from interruptions and facilitates the work. It prevents injury to the anti-corrosive coating of the wire, and adapts itself to the system of drawing wires out.

The Great Storm and Its Work.

The Atlantic seaboard was visited on Monday, the 12th, by a storm whose like cannot be recalled by the oldest inhabitant, and for which no parallel has yet been discovered in local meteorological records. The storm came without any warning from the Signal Service as to its approach, and passed away to sea almost as suddenly, leaving all New England as well as New York, New Jersey, Pennsylvania, Maryland and Delaware, buried in snow to a depth of at least 18 inches, on the average, and of thirty and forty feet in countless drifts. Not only were all the large and small railroads terminating in New York blockaded until the end of the week, but in the city the travel, which was totally suspended for a time on Monday, has hardly yet been resumed in its full volume.

This great snow fall was accompanied by a gale whose velocity frequently reached 50 miles an hour, and once or twice went up, it is said, to 84 miles, making the storm a genuine blizzard of the most pronounced and terrible type. Where the loss of life and property has been so heavy, it is no cause for wonder that the wires were broken and the pole lines destroyed in every direction. The damage to the wires is, in fact, utterly beyond precedent. Never before has the interruption of telegraph service been so complete, while the telephone system suffered no less, and all the other electric services were very seriously affected. It was not until Wednesday afternoon that Boston was able to renew communication with New York and the rest of the world, and then the news came by way of the Commercial cable, having to go to Europe before it could be delivered.

The damage to the wires was of so wholesale a character that to enter into the details would fill columns. In this city, hundreds of linemen were at work the whole week restoring wires that had been broken. The electric light wires, owing to their greater strength, enjoyed fair immunity, but owing to the numerous crosses the usual lighting of the streets was not attempted Monday, and as the gas was also under an eclipse, the streets were dark and dangerous. The Brush Company also suffered a little later in the week for a few hours from not being able to obtain a supply of coal. The electric power circuits were maintained throughout, and it deserves note that the Electric Power Company, using the Daft system, with overhead wires, began running daily ahead of time. The long distance telephone service was greatly interfered with, but when it was found that it was keeping up communication with Philadelphia, there was a big rush for its office. The police and fire services fared no better than the others, but tremendous exertions to restore them soon made both effective for serious calls, though not for the regular routine work.

The reports from Philadelphia, Baltimore, Boston and other cities showed a state of trouble with the wires almost as bad as that which prevailed in New York. At Lowell it was found impossible on Monday night to furnish electric lights on account of the many breaks in the circuits. The general experience in New England was that the telephone system came out of the ordeal in better shape than was expected, and furnished in many instances a useful substitute for the paralyzed telegraph service.

As pointed out in one of the daily papers, the complete isolation of New York by the great blizzard has suggested to certain persons the establishing of cable lines to connect New York with all the principal cities on the Atlantic seaboard, so as to guard, as far as possible, against the repetition of such an occurrence. It is not considered probable that all these points will ever be cut off from communication by land telegraph with the interior at the same time. And while any one of them remains in substantial connection with the country west of the Alleghanies and the shore line cables continue to work, neither New York nor Boston nor Philadelphia will ever be so completely isolated as they were during Tuesday last. The scheme has been submitted to some practical men connected with the Western Union Telegraph Company and it is said to have been received with apparent interest. The parties are now industriously considering the proposition and inquiring into the feasibility and probable expense of the scheme.

An interesting note as to one feature of the storm is made by the New York *Times*:

"If the power of the great storm, which has been now so thoroughly discussed, was everywhere a proof of the weakness of man, when the elements really make up their minds to do something, it also called forth, in some instances, a display of his wonderful intelligence and control of natural forces. One of the most interesting triumphs of invention was displayed during and after the accident on the Lehigh Valley Railroad, mentioned in the daily papers. This railroad for some months has been using on its trains the system of communication known as "train telegraphy," introduced by the Consolidated Railway Telegraph Company. By this system it was possible to telegraph from a moving train with as much promptness and exactitude as from a stationary office. This, of course, was an interesting thing in itself, but the action of the system during the storm has an added point of interest. The wire of the Railway Telegraph Company being of steel and stretched upon stout poles reaching only 15 or 16 feet from the ground, and not being strung on cross-arms but on the pole itself, withstood the fury of the storm and did not blow down. The wire and poles were both buried in the snow, but this did not, it proved, affect the current. The consequence was that all the stalled trains on the Lehigh Valley Railroad kept up constant communication with the terminus of the road, could define exactly their position, and, in short, had all the advantages of perfect telegraphic communication. In the case of the accident east of Three Bridges, where three locomotives and two construction cars were heaped up upon each other after attempting to cut through a snow drift 20 feet deep, the system of telegraphy was of great service in calling for aid and describing the situation of the train. Henry Lewis, the operator of the train, calmly sat on a flat car, with his telegraphic instrument in his lap, and the curious receiver, like the end of a telephone, strapped to his ear, and received and dispatched messages in regard to the train.

"This same principle has been experimented with between vessels at sea, and it is thought not impossible, by means of a cable laid from New York to Albany on the bed of the river, that there should be maintained constant communication with an operator upon any steamboat passing up or down the river. Henry D. Hall, treasurer of the Consolidated Railway Telegraph Company, of this city, said that Superintendent Donnelly, of the Lehigh Valley Railroad, was greatly pleased at the working of the system during the storm, and he thought that it would soon be used by other important railroad companies."

Electrostatic Attraction in Liquids.

In a note by M. Gouy to the Académie des Sciences, the author states that he has found that the attraction between two electrodes kept at a constant potential is far greater when these electrodes are immersed in a liquid than when they are in air; the attraction of a disc 87 millimetres in diameter placed in distilled water above a large surface of mercury, the disc and mercury being connected with the poles of an 8-cell bichromate battery, was found to vary as the square of the distance below the surfaces, and to be at least one hundred times as great as the attraction in air. The exact cause of the phenomenon seems doubtful.

Oxide of Copper Battery for Incandescent Lighting.

To the Editor of the Electrical World:

SIR: In Hospitalier's work on "Domestic Electricity," I read on page 19 of a battery, shown in Fig. 9, which can light a 5 c. p. Edison lamp for 200 hours.

I have set up two of these cells which are made of cast-iron; their size is 18 by 10 in. and 5 in. high, in which I have placed zinc plates, size 14 by 8 in. A solution of 30 or 40 per cent. of caustic potash should be used as exciting liquid, and the bottom of the cells should be covered with oxide of copper.

I have been in all leading drug stores here, but cannot buy the oxide of copper, so I would therefore ask you what to do in this case. (1) Is there any way that I can make the oxide?

If possible I would like to use the cells, and (2) will the two cells connected in tension run a 10 c. p. Edison lamp?

BUFFALO, N. Y. H. M.

ANSWER.—(1) If you cannot obtain the oxide of copper from any druggist in your town, you might try to obtain it from some large chemical houses in this city. You can prepare it yourself, however, in the following manner: Reduce the copper to as fine a grain as possible by pouring it into water while in a molten state, and then roast the granulated copper a red heat with continual stirring so as to give the mass plenty access to the air. The action of the latter oxidizes the copper, converting it into the black oxide. Continue this process until the grains are thoroughly oxidized. It might be possible also to procure the oxide as scale from copper rolling mills, if there be any near you. (2) Two cells of the Lalande battery which you refer to will hardly bring a 10 c. p. lamp to incandescence, as the E. M. F. of the cell is only .85 volt in continuous use.—EDS. E. W.

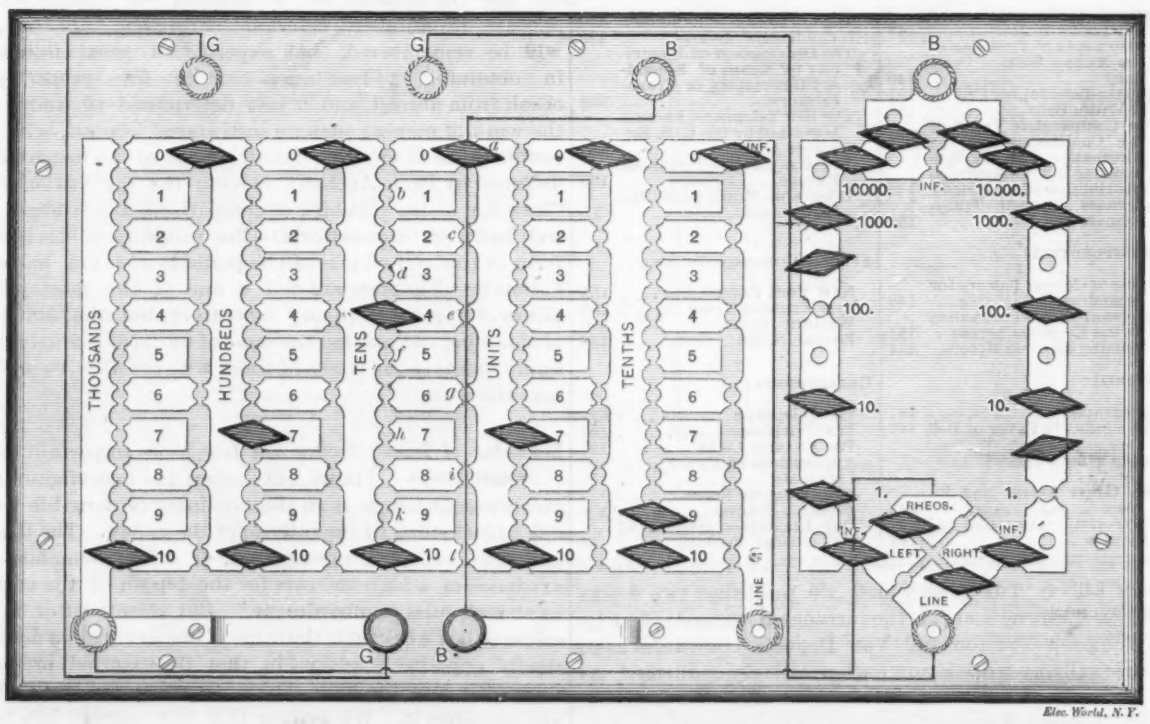
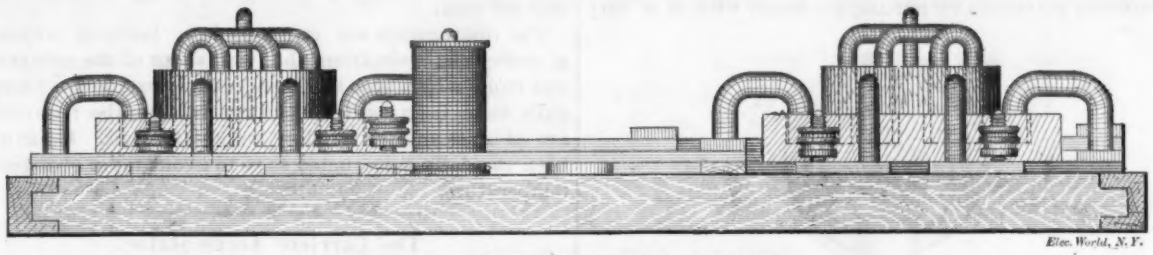


FIG. 1.—NEW RESISTANCE BOX AND BRIDGE, OF THE MATHER COMPANY.

Transmission of Power.—MM. Deprez, Bertrand, Lévy, Mascart and Becquerel have been nominated by a ballot of the Académie to act as judges for the *Grand prix des sciences mathématiques* for the present year. The subject chosen for the prize is, as our readers know, "the perfecting in some important points the theory of the application of electricity to the transmission of power."

Instruments of Precision of the Mather Electric Company.

For some time past Prof. Wm. A. Anthony, consulting electrician for the Mather Electric Company, of Manchester, Conn., has been engaged in the designing of various forms of electrical measuring instruments which should possess great accuracy and at the same time be of simple construction, so as to be easily manipulated and give ready indications. The value of such instruments in the workshop and laboratory need hardly be pointed out, and the manner in which the conditions have been met in the instruments described below will make their usefulness at once manifest.



Elec. World, N. Y.

FIG. 4.—DIVIDED WIRE BRIDGE.

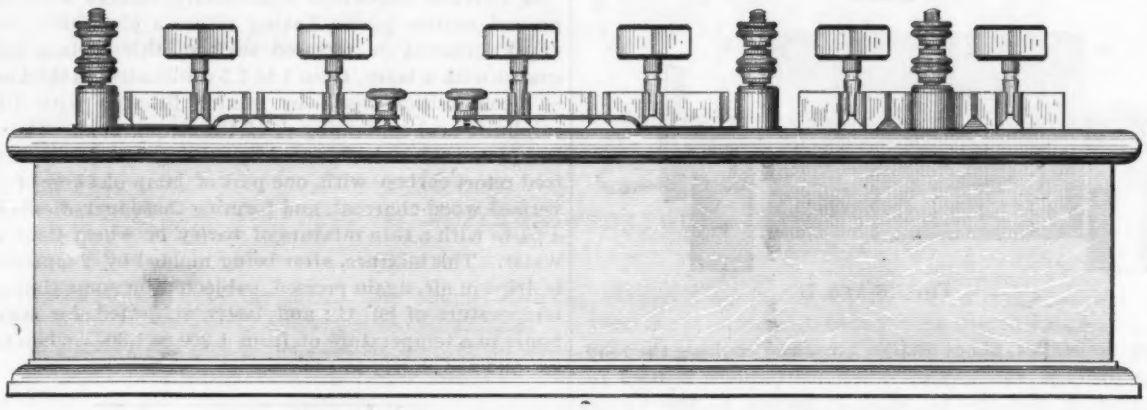


FIG. 2.—RESISTANCE BOX AND BRIDGE.

Beginning with the measurement of resistance, one of the most important in electrical work, the Mather Company have constructed for their own use for the general measurement of resistances and to be used also as standards of comparison in the construction of resistance sets, the standard resistance box and bridge shown in Figs. 1 and 2.

As will be seen from the engravings, the general arrangement adopted is that known as the "dial pattern" resistance box, but instead of the several blocks which serve as connections for the several coils being arranged in circles, they are arranged in straight lines. This facilitates the cleaning of the rubber top of the box under the brass blocks, which is a matter of very considerable difficulty with the "dial pattern" resistance box as ordinarily constructed.

The other special features are the arrangement of the proportional coils so that they can be reversed by changing two pegs, and the arrangement of the connections for resistances so that each one of the latter can be used separately, or the several resistances of one denomination put in multiple arc in any way. This is an important feature with a resistance box constructed for standard purposes, as it permits several coils to be compared with the standard very easily and readily, and permits also of the comparison of the coils among themselves with very great facility. For instance, taking the coil of the "tens" denomination; it is evident that with a peg at *a* and *b*, coil No. 1 would be measured; with a peg at *b* and *c*, coil No. 2 would be measured, and so on through the whole series of ten. Putting pegs at *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *k* and *l*, the coils of the "tens" denomination should be put in multiple, when their resistance should be equal to one ohm. The other special features will be understood from the illustrations.

As to the adjustment of these coils the series of ten "tens" was first made by reference to a standard coil of ten legal ohms, tested at the Cavendish Laboratory and bearing the certificate of Mr. Glazebrook, chairman of the British Association Committee. These coils were adjusted and re-adjusted until none of them differed from the standard by more than one-ten-thousandth of an ohm. The ten coils were then put in multiple arc, as indicated above, and compared with a standard legal ohm also tested at the Cavendish Laboratory, and found to agree with it with the greatest precision. The "unit" coils were then made by comparison with the ten "tens" in multiple, and the "tenths" by comparison with the ten "units" in multiple. The "hundreds" and "thousands" were made from the "tens" in the reverse way, and as a check on the accuracy of the work, the "hundreds" were put in multiple arc, when, of course, the resistance should equal one of the "tens." These checks were all applied, and the resistance box was found to be satisfactory in every way, and it is believed that it is not possible to find anywhere in it a variation of so much as one one-hundredth of one per cent.

In order to avoid the changes that would result from differing temperature coefficients, the rods by which the "tenths," "units," and "tens" were connected to the blocks were made of German silver, and the same was also done for the proportional coils, one, ten, and one-hundred.

Figs. 3 and 4 represent a form of divided wire bridge, constructed for making comparisons of resistance coils with the standards while in process of construction. It was found desirable to have a wire bridge in which the wire should be long enough to have a resistance of one ohm, and still show very plainly a tenth of an ohm. In

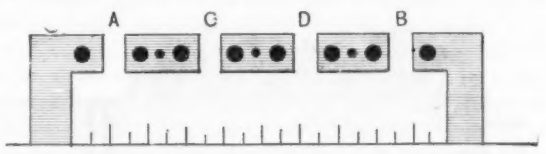


FIG. 5.

order to make use of a wire of the desired length, it was considered best to wind it upon a cylinder. It is believed that the bridge shown in these illustrations offers some peculiarities which would render it very useful for such purposes and for other comparisons where small differences are to be determined.

Fig. 3 shows a plan view of the bridge without the cylinder which carries the wire. *A* and *B* represent the posts which support the bearings of the cylinder, and for the purpose of description it may be considered that the wire is stretched from *A* to *B*.

Fig. 5 represents the typical arrangement of the divided meter bridge. It will be seen that the two resistances marked "standard unit" and "resistance to be measured", of Fig. 3, connect the gaps *A* and *B*, Fig. 5, of the typical form of bridge, and that the resistances *M* and *N* connect, respectively, the gaps *C* and *D*. This bridge was designed especially for comparisons of resistances by the "Carey-Foster method," in which the resistances to be compared are placed in the gaps *A* and *B*, Fig. 5, and the balance obtained; then the two resistances *A* and *B* being exchanged and the balance again obtained, the resistance of the bridge wire between the two points of balancing is the difference of the resistances compared. *M* and *N* are any convenient resistances, and remain unchanged during any comparison.

Attention must be specially called to the arrangement by which the two coils to be compared are interchanged. This is done by means of the commutator *C D*, which consists of a block having in it eight cavities, at the bottom of which are pieces of copper that have been carefully amalmagated, and on which rest the rods of copper shown in the illustration. *D* is a circular block through which the copper staples slide freely. On lifting the block *D* and turning it a quarter of a revolution, it will be seen that the two coils to be compared are interchanged with respect to the gaps of the bridge by that one operation. A similar commutator on the left hand of the figure serves to interchange the two resistances *M* and *N*, if it is desired to do so for any purpose.

Figs. 6 and 7 show the cylinder on which the bridge wire is wound with the bearing of the cylinder in section, from which will be understood the method by which the difficulties due to variations of risistance ordinarily met with in a sliding contact have been overcome. The central portion of the bearing and the box in which it runs have been thoroughly amalgamated and the bearing runs in mercury, so that the contact at that point is a mercury contact, and is as perfect as any other mercury connection. We may add that the bearings, supports, ends of the cylinder, the connecting strips and rods, as also the binding screw post and nuts, are all made of copper, so as to avoid as far as possible, any variations due to thermo-electric currents. The only thing about the instrument, in fact, which is not made of copper is the bridge wire, which is made of German silver, obtained from the Scovill Manufacturing Company, having a temperature of coefficient of only .00022.

The whole instrument is mounted upon a wooden base which was immersed in hot paraffine and kept there as long as any bubbles escaped, and then left to cool off until the paraffine was nearly solid. Such a block is a very good insulator; in fact, it has been found possible to obtain sparks 5 or 6 inches long from a Holtz machine in which the insulators were made entirely of wood so treated. The cylinder on which the bridge wire is wound is of hard rubber, 4 inches in diameter, and the wire itself makes 52 turns. It is adjusted by means of a shunt inside of the cylinder, so that 50 turns of it have a resistance of exactly one ohm. It is also so arranged that by means of another shunt the resistance of 50 turns may be made one-tenth of an ohm. The 50 turns are divided into 10,000 equal parts by the divided circles attached to the cylinder, and each one of those parts is very nearly a millimetre. The galvanometer used with this bridge shows a variation too small to be estimated upon these divided circles, so that it will be seen that differences smaller than a hundred-thousandth of an ohm are readily observed, and it has been found that with the instrument working to this degree of precision, the various contacts can be relied upon, by proper care in manipulation, not to introduce noticeable errors.

This instrument can also be used for the measurement of very small resistances by the method proposed by Sir William Thomson, in which the resistance to be measured

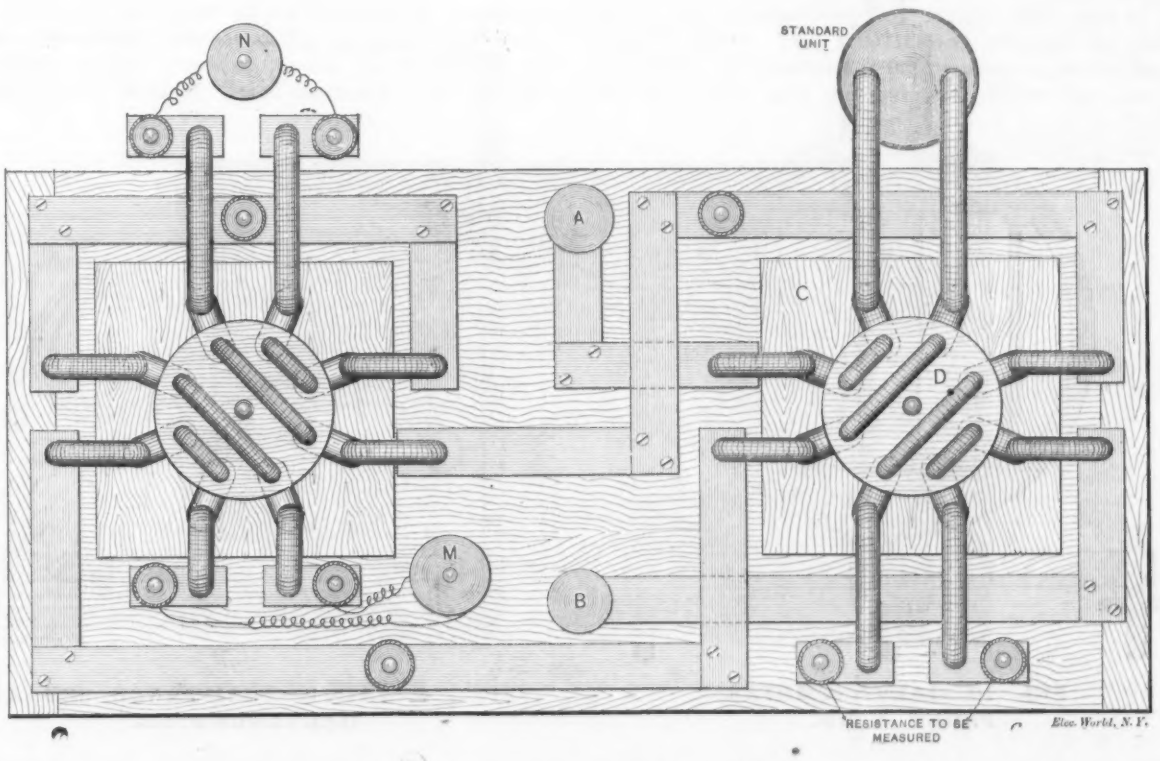


FIG. 3.—DIVIDED WIRE BRIDGE.

is compared directly with a certain length of the bridge wire by a method in which all contacts are left entirely out of account.

To the instruments just described we may add a small resistance set and galvanometer combined, shown in two views in Figs. 8 and 9. As will be noted, the galvanometer needle is suspended by a silk fibre and is extremely sensitive. The coils are made of wire considerably larger than is usually used in such resistance sets, and they have been adjusted to a high degree of accuracy. The proportional coils are one, ten and one hundred on one side, and ten, one hundred and one thousand on the other side, and they are so arranged that either arm of the proportional coils can be connected to the resistance set, and so a ratio of one to a thousand can be obtained. The proportional coils have been adjusted with extreme accuracy, and the ratios are perfectly exact.

In connection with the instruments just described there have been constructed a pair of tangent galvanometers to be used as potential and current instruments. As shown in the engravings, Figs. 10 and 11, they are constructed on the Helmholtz plan, and are so arranged that the measurements for determining the constants can be very accurately made. For special reasons these instruments were wound with German silver wire, and each coil consists of ten layers and ten turns in each layer. Instead of winding the coils with a single wire, they were wound with two wires which are wound on at the same time side by side, and in the second layer the wire which was on the right in the first layer is changed to the left; and they are reversed in that way in each successive layer so that the two wires occupy as nearly as possible the same position with reference to the needle.

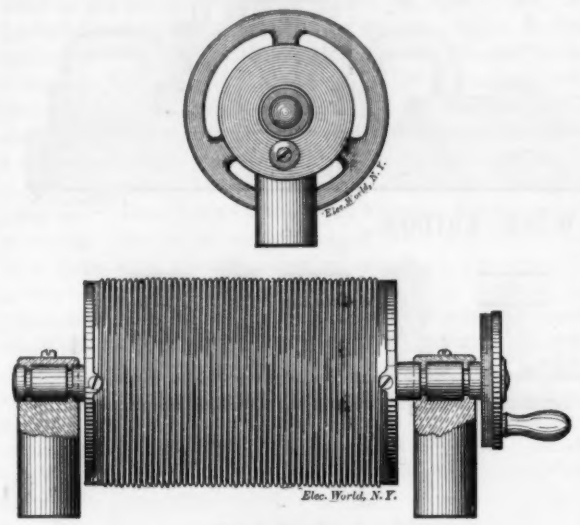
The winding with two wires has a twofold purpose. First, it permits the galvanometer to be used over a wider range; but the second and principal purpose was to make sure that that there were no short-circuits in any of the coils during the winding. It was assumed that if these two wires were perfectly insulated from each other when the winding was complete there could be no short-circuit anywhere that would cut out even a single turn of the wire, and it will be understood from what is said above as to the way in which the coils were wound, that it would be almost an impossibility that such a short-circuit would occur. The galvanometer then consists practically of four coils which may be coupled up in any way by means of the little switch-board shown at one side of the instrument, Fig. 11. The needle is suspended by a silk fibre, which has been made of very considerable length in order that the effect of torsion might be reduced to a minimum. Since the torsion, whatever it may be, is a somewhat variable quantity, changing with the state of the atmosphere, it was considered important to make it as small a quantity as possible. The needle is suspended in a cavity in the copper block *A*, the effect of which is to make it very nearly "dead beat."

The movements of the needle are observed by means of a telescope and scale in the usual way, except that the scale has been placed at such a distance and bent on such a curve that the difference between the two readings obtained on reversing the currents is the tangent of the angle of deflection. The scale, two metres in length, divided into millimetres and numbered in centimetres, is placed at two and one-half metres distance from the mirror and is curved to a radius of five metres, which gives within the range of the instrument very accurately exact tangents.

As stated above, one of these instruments is used for measuring potentials by putting in circuit with it a very high resistance, about 50,000 ohms, and making the reading exactly volts. The other instrument is used for measuring currents by what is known as the Vienna method, which consists essentially of taking the difference of potential between two points at a very low resistance through which the current is flowing. The resistance in this case is formed of German silver strips which are immersed in a tank of kerosene oil, in which are stirrers for thoroughly mixing the oil and so bringing it to a uniform temperature through the whole mass. The two instruments are mounted upon piers placed near two corners of the building and the telescopes and scales are placed near the centre of the room in a position to be conveniently used by one observer, or two instruments may be observed by separate observers, if desired.

By varying the resistance in the circuit of the tangent galvanometer, currents from fractions of an ampère to 500 ampères can be measured, and in the same way potentials may be measured from fractions of a volt to 2,500 volts, and with the same percentage of accuracy through the entire range. The constants of the current instrument have been checked by a long series of tests by means of the copper and silver voltameters, the constants of the potential instruments being checked at the same time by taking the potential between the two ends of a known resistance. The constants have also been checked by reference to Clarke cells, six of which have been constructed on the premises, two of each from different lots of chemicals, and the various checks so applied agree with each other very satisfactorily. These tests are repeated from time to time, and the results agree with each other so well that it is felt that the constants of the instruments for any given temperature and for different times in the day can be fixed to within one-fifth of one per cent.

The instruments are mounted in a building which is at some distance from the workshops of the company, and from which iron has been entirely excluded. Copper nails have been used in its construction; the trimmings are of brass and the window weights of lead. It has also been carefully constructed so as to avoid rapid changes of temperature.



FIGS. 6 AND 7.

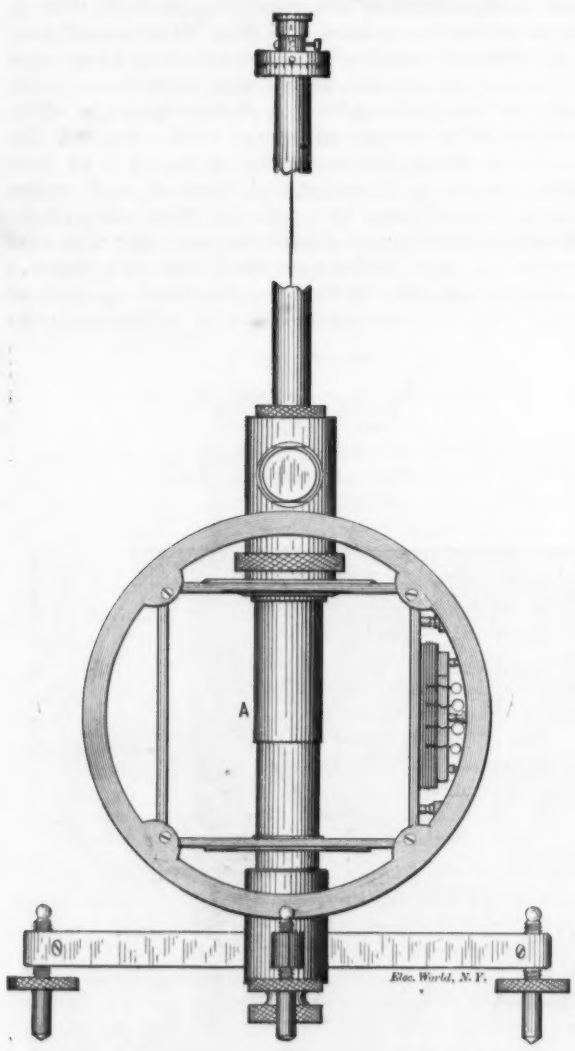
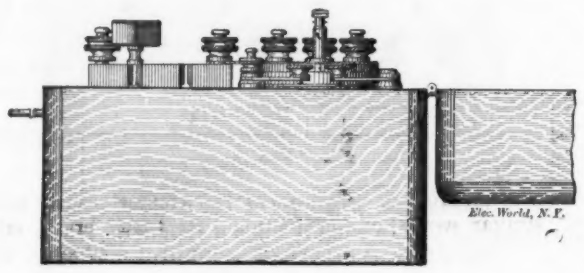
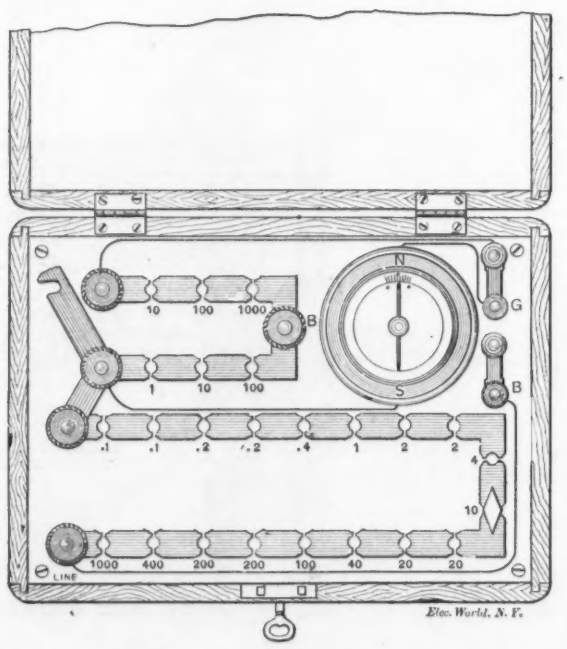


FIG. 10—GALVANOMETER. FRONT VIEW.





FIGS. 8 AND 9.—RESISTANCE SET AND GALVANOMETER.

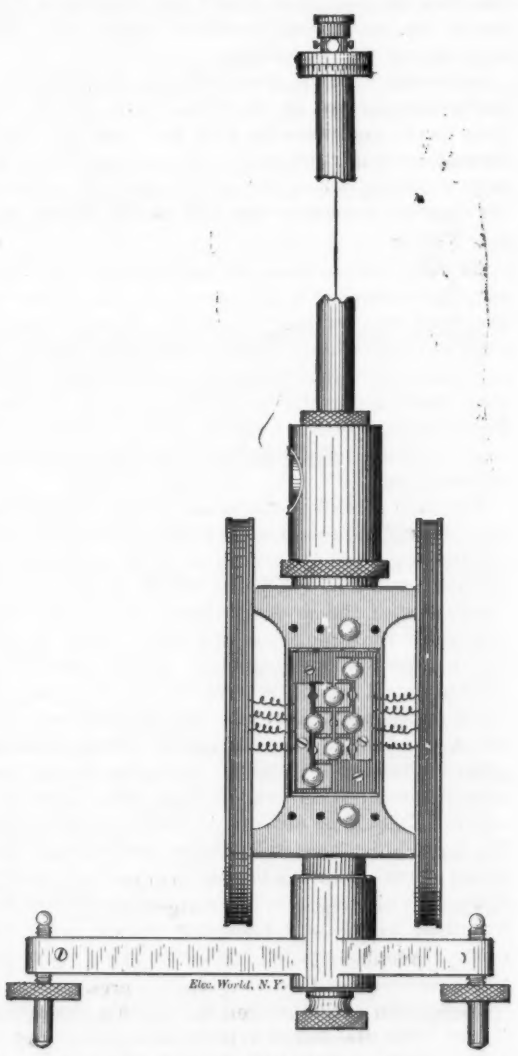


FIG. 11.—GALVANOMETER. SIDE VIEW.

The Carriere Accumulator.

M. Carrière constructs a secondary battery with compressed carbon plates, having either a plane or a corrugated, grooved or recessed surface, this surface being coated with a layer, from 1 to 1.5 millimetres in thickness, of a composition made by mixing litharge with dilute sulphuric acid containing $\frac{1}{10}$ of the strong acid. The carbon plates are manufactured by mixing 2 parts of pulverized retort carbon with one part of lamp-black or of pulverized wood-charcoal, and forming these ingredients into a paste with a thin mixture of barley or wheat flour and water. This mixture, after being molded by compression, is dried in air, again pressed, subjected for some time to a temperature of 80° C.; and lastly subjected for several hours to a temperature of from 1,200 to 1,300°, when they are allowed slowly to cool.

Incandescent Lamps.

Commenting on the fact that the efficiency of incandescent lamps with stout filaments is greater than those with fine, M. Hospitalier points out in *L'Electricien* that several different causes combine in rendering this the case. If, for example, we take the case of two lamps, each absorbing 64 watts, but let one have a fine filament having a resistance of 64 ohms, whilst that belonging to the other is one-fourth the length and four times the diameter, thus having a resistance of one ohm only, then the volume of the second will have consequently a greater calorific capacity, so that the effects of any accidental variations in the strength of the current will be greatly diminished. Moreover, the section of the second filament will be 16 times that of the first, whilst the current passing through will be only eight times as great, hence the current density will be only one-half of what it is in the fine filament. Adding to this the fact that it is easier to secure uniformity in the manufacture of stout filaments than of fine, there appears ample ground theoretically for the longer life of stout filaments, which practical experience shows.

A Stylo-Telegraphic Pen.

A decidedly novel transmitting instrument designed for learners of telegraphy and designed also for experts has been recently brought out by Mr. H. P. Copeland, of East Orange, N. J. The instrument is in the form of a pen which supports the wires of an electric circuit, and has two corresponding terminals for making and breaking contact, one of them being a spring terminal placed in such a position as to be moved into contact with the other in the act of making a heavy stroke in writing.

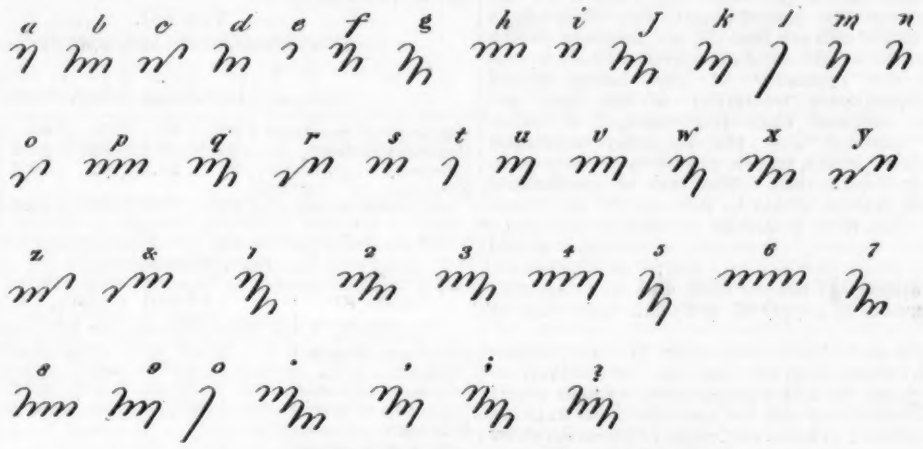


FIG. 5.—STYLO-TELEGRAPHIC ALPHABET.

Fig. 1 shows the pen in perspective, *o* being the movable terminal upon which the index finger naturally rests in using the pen. Fig. 2 shows the arrangement of the parts within the pen casing. The terminal which corresponds to *o* is *p*, and each is connected by a wire with one of a pair of metallic rings at the outer end of the pen.

By referring to Fig. 3, it will be seen that the cap which covers the outer end of the pen is provided with internal metallic rings *d' e'*, which correspond in position to the rings *d e*, respectively. The rings within the cap are joined to the circuit wires, which enter the cap at its outer end. When the cap is put in place there is a circuit through the rings and through the wires within the pen, the circuit being open between the points *o* and *p*. Supposing the circuit to include a suitable battery and receiving apparatus, it is evident that the receiver will respond every time that a contact is made at the open part of the circuit. By regulating the duration of the closure at that point, the transmitter can be made to send either dots or dashes of the Morse code at will. The diagram, Fig. 4, illustrates a system of circuits with which the pen transmitter can be employed.

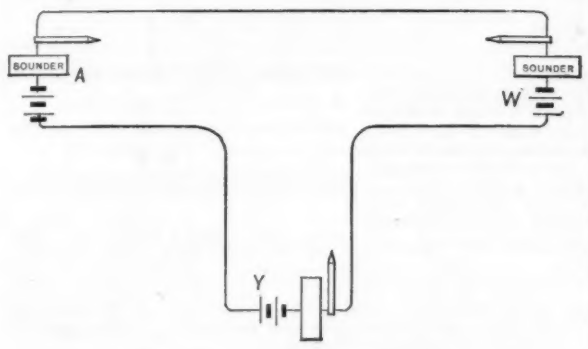


FIG. 4.—DIAGRAM OF CIRCUIT.

The inventor has in view primarily the object of providing means whereby beginners in telegraphy may be relieved of the necessity of depending solely on sound in transmitting telegraphic messages, and may be guided, to some extent, by the eye as well.

The invention is also calculated to be used advantageously by more skilled operators for preserving a record of messages for future reference. Such a record might often serve to settle disputes between senders and receivers.

In adapting his invention to use, Mr. Copeland has prepared a set of stylo-telegraph characters, which are nothing more than the Morse dots and dashes rendered into script. The alphabet is shown in Fig. 5.

The downward stroke of the pen makes either the dot or the dash; the upward stroke the spaces. Taking the dot as a unit, the dash is twice as long, except those making the characters, letter "L" and the figure "0," which are four times the length of a dot. The ordinary space between the elements in a character is the length of a dot; the extraordinary ones in characters, C, O, R, Y, Z, &, are twice the length of a dot.

These characters can be written like ordinary script in a flowing hand, but, if preferred, the pen can be used to make the usual dashes and dots without any attempt at joining them. In either case but little practice is said to be required before an operator, by a perfectly natural use of the instrument, will make the proper impulses for sending intelligible messages over the line. The contacts *o p* will be brought together by an operator using the script form of characters only during the down stroke. It follows, of course, that the length of the down strokes will determine whether a dot or a dash is sent.

The pen employed may be a fountain pen or a pen of any other type, or, if preferred, the pen may be replaced by a stylus or by a pencil.

A cap is provided for the point of the pen so as to keep the points *o p* permanently in contact when the pen is not in use, and thereby maintain the circuit in proper condition, or closed. A spring *i* in the cap at the other end of the pen closes the circuit between *d'* and *e'* except when the cap is in place. Thus the cap can be withdrawn from the pen and the latter be employed for ordinary writing purposes without deranging the operation of the system.

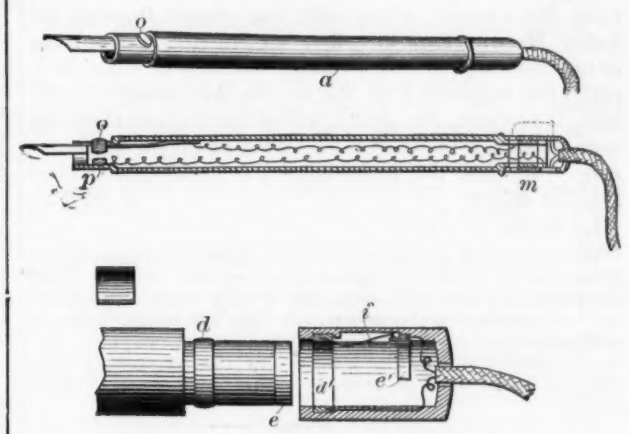
The Catlin Grip.

An excellent little work entitled "Philosophy and Practice of Morse Telegraphy," from the pen of Mr. T. J. Smith, has just been published by the E. S. Greeley & Co. It presents a rational and practical guide for the young telegrapher, intended to make him acquainted early in his career with a few underlying facts and laws that usually, without specific study, only come to his knowledge after years of service and practical observation. In it the author makes claim to the credit of exploding an erroneous impression with regard to the true position of the telegrapher's hand and wrist when in the act of writing on the key, which error, it is claimed, has been heretofore disseminated to a considerable extent in illustrations by similar works of instruction. In these erroneous exemplars the hand is bent at the knuckles, congesting the hand and destroying the flexibility of the jointure of the bones of the hand and forearm at the wrist by compressing them.

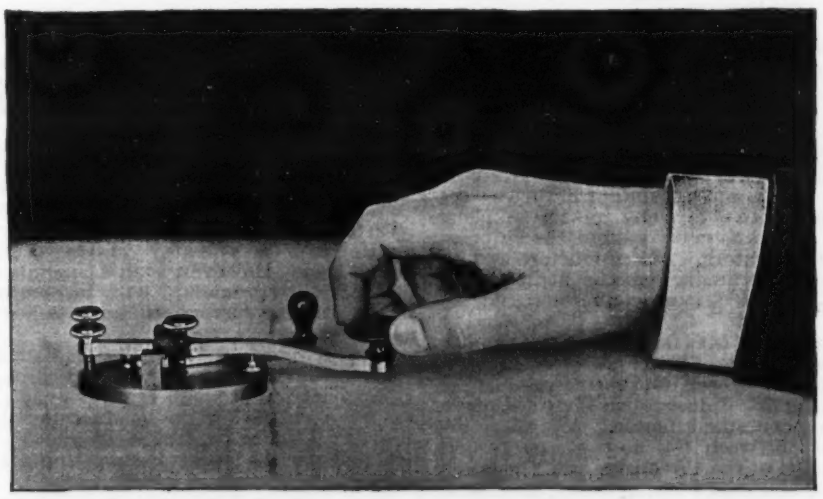
In order to illustrate the correct mode of handling the key, the author has taken for his model the position adopted by Mr. Frederick Catlin, the well-known wire chief of the Western Union main office, whose skill at the key has been manifested on more than one occasion. Our illustration, for which we are indebted to the publishers, shows the position admirably, and the following additional directions given may aid some in obtaining the desired rapidity of stroke:

Take hold of a key just as you would of a pen, the index finger forming a convex figure or arc resting on the top of the key knob, and the thumb pressing slightly upward on the lower side of the knob. A straight stiff forefinger should be avoided. A concave finger is worse. The second finger often rests upon the top of the key knob also, together with the index, but if found more comfortable, let it drop down alongside of the knob, there being no objection to that position, as will be seen by reference to the illustration.

Work is the most easily done when the key is set so far back on the table that the elbow has a rest on the same bed. When sufficient depth of desk cannot be secured, the forearm should rest on the edge of the desk, but under no circumstances should the wrist be allowed to lie or rest upon the table; on the contrary, it should be raised therefrom a couple of inches, and move up and down in harmony with the hand, allowing the elbow or forearm, as the case may be, to act as the axis or hinge of the movement, assisted by flexibility at the wrist. The nature of the "grip" upon the key should be similar to that in seizing a pen. It should be light, gentle, but even and sure. It must be firm enough to secure unquestioning obedience of the lever, but must not be rigid. Indeed when we say handle a telegraph key as you would a pen, we have said everything.



FIGS. 1, 2 AND 3.—STYLO-TELEGRAPH PEN.



THE CATLIN "GRIP" IN KEY MANIPULATION.

Effects of Animal Organism on the Electric Current.

To the Editor of The Electrical World:

SIR: In your issue of February 18 there appeared an article by C. H. Murray, describing the effect produced by causing an animal organism to form a part of an electric circuit. Mr. Murray's statement is as follows: "If the ends of the wire carrying the current be held in the mouth only a millimetre apart, no matter how strong the current, it will have no effect on the most delicate galvanometer; it is destitute of magnetism."

Now, in your issue of March 10 there are two articles on the same subject, contradicting Mr. Murray's theory. The writer of one of these articles (M. C., of Camden, N. J.) ridicules Mr. Murray, his theory, and his instruments, and flatly contradicts Mr. Murray's above statement. I would like to call the attention of the authors of the articles mentioned to some experiments which I have made, and which I think support Mr. Murray's theory.

The experiments, briefly, are as follows: I connected up a battery of six Leclanché cells in circuit with a galvanometer, thereby, of course, obtaining a strong deflection of the galvanometer. Then, making a break in the circuit, I substituted my tongue for a part of the metallic circuit. This substitution destroyed the deflection of the galvanometer. I then made a second break in the circuit, and an assistant placed the ends of the wire on his tongue, thus interposing two living animal organisms in the circuit. And now comes the important point. No deflection of the galvanometer was obtained but both myself and my assistant distinctly felt the passage of the current on our tongues. The sensation produced by the current seemed to me more intense than the sensation produced by only one cell; and this supposition I verified by trial. Now, a single cell produced a strong deflection of the galvanometer, but the current from the six cells, when used in the manner described, produced no deflection whatever, although of apparently greater strength than that of the single cell. This, I think, shows that the non-deflection of the galvanometer is not due to the increase of resistance in the circuit.

I then substituted different kinds of meat, both raw and cooked, in place of the live organism, the tongue, and obtained a considerable deflection of the galvanometer. This seems to indicate that live animal organisms will de-

magnetize a current, while organisms in which life is extinct have no effect other than increasing the resistance of the circuit.

The results of the foregoing experiments are, I think, conclusive proof of some correlation between electricity, magnetism, and the vital force. I do not mean to go so far as to say that the strongest currents are entirely demagnetized by passing through a live animal organism, but I do venture to state, that any small current, like the one I have referred to, will be demagnetized for all practical purposes by passing through a live animal organism. If the gentleman who treats this idea as being so utterly ridiculous, will perform the above mentioned experiments for himself, I think that he will find that there is something in this discovery of Mr. Murray's after all.

S. S. E.

NEWTON CENTRE, Mass.

To the Editor of The Electrical World :

SIR: In recent issues I noticed a communication from Mr. C. H. Murray and a number of criticisms by others. The thing reminds me of a very old experiment, and if Mr. Murray has not instruments of sufficient delicacy, or has not currents of high E. M. F. at his command, I would suggest that he try the following experiment: Let him go to the nearest telephone and disconnect one wire from the receiver, completing the circuit through his body. He will, I am sure, find no difficulty in speaking or hearing through this, although the current which generates the magnetism in the receiver *has* passed through him. If he thinks the sifting process has not been thorough enough, he can increase the number of people in the circuit. I thought this experiment was so old that all were familiar with it. J. E. P.

LA PORTE, IND.

We think that the untenableness of the theory advanced by our original correspondent is sufficiently evident without requiring any further proof, if any were needed at all. It suffices for the rest to say that the author himself acknowledges, in a manly communication we have received from him, that he was led to the erroneous conclusions by the lack of delicacy in his instruments.—EDS. E. W.

The Comparative Value of the Continuous and the Alternating Current Systems for the Commercial Distribution of Electricity.*

BY H. WARD LEONARD.

There exists to-day a great deal of uncertainty in the minds of many persons interested in the distribution of electric energy as to the comparative value of the continuous current three-wire system and the alternating current converter system; and as the published statements relative to these two systems have apparently greatly exaggerated certain advantages and disadvantages of the one system and the other, I will endeavor to institute what I consider as fair a comparison as possible between the two systems, using the best data at my command, and giving due weight to the several factors necessary in a general system for the distribution of electric energy on a commercial scale.

In considering the comparative value of these two systems, let us compare them with each other upon the following points, which I consider the vital ones in a general supply system of electric energy:

First. First cost.
Secondly. Economy, efficiency and depreciation.
Thirdly. Reliability.
Fourthly. Variety and value of the possible sources of revenue.
Fifthly. Safety to life.
Sixthly. Effects upon existing property.

First Cost and Economy.—This is a feature which is subject to variations which are not similar in the two systems, and it may be well to give some general explanations of the cause. In a three-wire system the principal items of cost are the generators, main conductors and inside wiring. In the alternating system the main items of cost are generators, primary circuit, converters and secondary circuit.

The cost of the generators is as far as I am able to judge by inspection and comparison of prices about the same. At any rate, any possible difference in this respect must necessarily be but slight in its influence on the total cost of which it becomes a very small factor. We, therefore, come to a comparison between the cost of the feeders, mains and inside wiring of the three-wire, and the cost of the mains, converters and inside wiring of the alternating system.

The cost of the conductors transmitting a given amount of energy at a given loss for a given distance varies, generally speaking, inversely as the square of the initial electromotive force employed. For instance, if the E. M. F. of one system be 1,000 volts, and that of another be 110 volts, the cost of conductors for the latter under similar conditions would be to the cost of the former as 1,000,000 ($1{,}000^2$) : 12,100 (110^2); *i. e.*, as 82 : 1.

In the three-wire system double the E. M. F. of the lamps is used, and the practical effect is the same as if the lamps were operated in series as far as the two outside conductors are concerned.

We saw that the cost of a conductor for a 110 volt two-wire system and a 1,000 volt converter system was as 82 is to 1. It is now evident that by using the three-wire system this ratio becomes as 27.5 is to 1.

The three-wire system is not of course limited to the electromotive force quoted. The Edison Company operate dynamos of 1,200 volts in a three-wire system for their municipal system.

The standard three-wire system of to-day is limited by the difficulty in manufacturing lamps of much higher voltage than 110. When the time comes, and it seems near at hand, that lamps can be had of double the voltage of those, the cost of conductors of the three-wire system will be one-fourth of what it is to-day; or, in other words, existing conductors will be able to supply four times as many lamps as at present, and at the same loss; also, an increase in the economy of the incandescent lamps would reduce the cost of conductors proportionately, and we can, of course, expect to see very great improvements in this direction.

It is evident, therefore, that the cost of conductors in the three-wire system will be reduced by inevitable improvements in the lamp itself to but a small fraction of its present cost.

Now let us look at the alternating system under similar conditions. Outside of the generator the converter is the principal item of cost, the cost of conductors being slight in comparison, as we will see later. An increase in the voltage of the lamps would be of no benefit whatever, and an increase in the economy of the lamps would result in a proportional reduction in the cost per lamp. Let us suppose that the voltage of existing lamps be doubled, and the economy increased 25 per cent., both of which results are likely to be seen in a very few years, if not sooner. The cost of conductors for the three-wire system would be reduced 80 per cent. and the cost of converters would be reduced 20 per cent., or, in other words, existing three-wire conductors would be able to supply five times as many lamps as at present, an increase in capacity of 400 per cent. and existing converters would be able to supply 25 per cent. more than at present.

So much for the probable reduction in first cost consequent upon improvements in the economy of the lamp itself, the only place in any incandescent system where much increase in economy can be expected, as existing devices are all claimed to have, and most of them do show an individual efficiency of 90 per cent. and upwards.

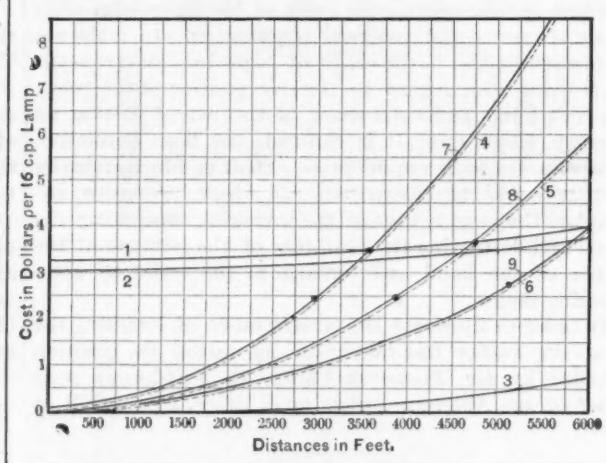
Let us now examine the comparative cost, as these systems exist to-day. In order to do this, it becomes necessary to determine the cost of conductors under the varying conditions met with in practice; and this can be conveniently done by applying the following formula deduced by the writer, the accuracy of which has been tested by practical use for about two years :

Let *T. C. P.* be total candle-power.
Let *D* be the mean distance current travels (one way).
Let *L* equal price per pound of copper (in cents).
Let *V* be volts lost in conductors (both ways).
Let *E* be E. M. F. of lamps.
Let *C. H. P.* be candles per electrical horse-power.

$$\text{Then } \$ = \frac{T.\,C.\,P. \times D^2 \times L}{V \times E \times C.\,H.\,P. \times 1{,}000}$$

For the three-wire system, one-third of this value is to be taken.

Before proceeding to apply the formula, let us clearly understand that with a continuous current the loss in conductors is exactly proportional to the amount of energy they transmit; *i. e.*, any variation in the load causes a proportional variation in the loss in conductors.



DIRECT VERSUS ALTERNATING CURRENT DISTRIBUTION.

With the alternating current this is not the case, the decrease in the energy transmitted resulting in but a slight decrease in the current. Thus, with a continuous current the loss in conductors under conditions of one-quarter load is one-quarter what it is at full load, but with the alternating current the loss in conductors at one-quarter load is probably 75 per cent. of what it is at full load. However, as this conclusion is based mainly on theoretical grounds, I will, in comparison, grant that the alternating current will be as efficient in this respect as the continuous current.

Careful examinations of the load diagrams of some 50 Edison central stations, show that throughout the run the average load is from 33 to 40 per cent. of the maximum load; *i. e.*, if the loss in conductors is 10 per cent. when the full load is on, the average loss throughout the whole time the plant is supplying light is but 4 per cent.

Table I shows the maximum loss expressed in volts, the corresponding maximum per cent. of loss, the corresponding average per cent. of loss, and consequently the average efficiency of the system of conductors:

TABLE I.

System.	Three-wire system.			1,000 volt alternating current system.		
Maximum loss in volts..	12.5	20	30	25	50	100
Maximum loss in per cent	10	15	20	2.5	5	10
Average loss in per cent.	4	6	8	1	2	4
Average efficiency.....	96	94	92	99	98	96

These two tables show the individual efficiency of the different portions of the two systems, and the total efficiency from the driving belt up to and including the portions named. I have granted in all cases for the converter system an efficiency of 98 per cent. for the primary, and 99 per cent. for the secondary conductors. With a commercial efficiency of 90 per cent. for the generator and 95 per cent. for the converter, which is sometimes claimed for them by some, the total efficiency is 82.9 per cent. With a commercial efficiency of 85 per cent. for the generator and 90 per cent. for the converter, which is believed by others to be liberal, the total efficiency is 74.2 per cent. In the three-wire system we have assumed an efficiency of the generator of 92 per cent., which result is obtained by every maker of a first-class dynamo of this type, and an efficiency of 99 per cent. for both the mains and the inside wiring, both of which portions of the system are in practice calculated for a maximum loss of 2 per cent.

The maximum loss in the feeders in table number 2 is made 10, 15 and 20 per cent., with a corresponding average loss of 4, 6 and 8 per cent., and an efficiency of 96, 94 and 92 per cent.

TABLE II.

Alternating Current Converter System.

	Indv.	Total.	Indv.	Total.	Indv.	Total.
Efficiency of generator.	90	90	88	88	85	85
Efficiency of feeder ...	98	88.2	98	87.2	98	83.3
Efficiency of converter.	95	83.8	92	79.3	90	75
Efficiency of services and inside wiring....	99	82.9	99	79.5	99	74.2

Three-Wire System.

	Indv.	Total.	Indv.	Total.	Indv.	Total.
Efficiency of generator.....	92	92	92	92	92	92
Efficiency of feeder	96	88.2	94	86.5	92	84.6
Efficiency of mains	99	87.3	99	85.6	99	83.7
Efficiency of services and inside wiring.....	99	86.5	99	84.7	99	82.9

Assuming the highest efficiency claimed for the alternating current generator, and assuming the generator is as efficient as a continuous current generator under conditions of partial load—which is not likely—and assuming that the converter has the same efficiency under partial load as under full load—which we know cannot be—we still are met with the fact that the three-wire system with a maximum loss of 20 per cent. in the feeders has as high an efficiency as the converter system, allowing it every possible claim, and that the three-wire system as usually installed, with a maximum of 10 per cent. loss in feeders, has a superior efficiency of from 4 to 12 per cent. over the alternating current converter system.

To return now to the question of first cost. Assuming the cost of copper at 16 cents per pound, I have figured the cost of copper conductors for feeders for 16 candle power, 50 watt lamps for distances of 1,000, 2,000, 3,000, 4,000, 5,000 and 6,000 feet, with an average loss in conductors of 4, 6 and 8 per cent. for the three-wire system and 2 per cent. for the alternating system with 1,000 volts initial E. M. F.; cost is expressed in dollars and decimal fractions thereof.

TABLE III.

Cost of Copper for Three-Wire Feeder per 16 c. p. lamp (50 watts, 110 volts). Copper at 16 cents per lb.

Distances.....	1,000	2,000	3,000	4,000	5,000	6,000
12.5 volts maximum loss equals 5 volts average loss, which is 4 per cent	.266	1.064	2.394	4.253	6.65	9.576
20 volts maximum loss equals 8 volts average, which is 6 per cent.....	.1615	.646	1.453	2.584	4 037	5.812
30 volts maximum loss equals 12 volts average, which is 8 per cent	.1077	.430	.969	1.723	2.69	3.87

Cost of Primary and Secondary Circuits and Converters for 1,000 Volt Alternating Current Converter System, per 16 c. p. lamp, at varying distances.

Distances.....	1,000	2,000	3,000	4,000	5,000	6,000
Primary.....	.0213	.085	.191	.340	.530	.764
Converter	3.000	3.000	3.000	3.000	3.000	3.000
Secondary..	.240	.240	.240	.240	.240	.240
Total.....	3.2613	3.325	3.431	3.580	3.770	4.004

I have also calculated the cost of copper in the mains for one 16 candle-power lamp on the basis of a distance of 800 feet between feeder terminals in the three-wire system and a maximum loss of 2 per cent. and find it to be thirteen cents. Also the cost of services and inside wiring in the three-wire system on basis of an average distance to lamps of 100 feet, and 2 per cent. loss, and since the full benefit of the three-wire distribution cannot be attained in the inside wiring, have assumed the saving of one-third over the two-wire system instead of the two-thirds saving effected in cases where the full benefit can be attained. On this basis the cost of copper for services and inside wiring is six and one-half cents per lamp.

In the alternating current converter system I have assumed the cost of converters recently quoted by Mr. Stanley, the electrician of the Westinghouse company, in a paper before the Boston Society of Arts. This figure is three dollars per lamp. I have calculated the cost of copper per 16 c. p. 50 volt and 50 watt lamp with an average distance to the lamp of but 75 feet, and with 2 per cent. loss, and found the cost of copper to be 24 cents per lamp. With an average distance of 100 feet, as was assumed in the case of the three-wire system, the cost of conductors for the inside wiring would be 43 cents. In making the comparisons, however, we will give them the advantage due to the 75 feet distribution; that is, 24 cents per lamp.

I have plotted these results, expressing cost as ordinates, and distances as abscissæ. The curves resulting are here shown. See diagram.

In the diagram curve No. 1 shows cost of primary converter and secondary for alternating system (converters at $3 per lamp).

No. 2 shows cost of primary and converter for alternating system.

No. 3 shows cost of primary for alternating system.

No. 4 shows cost of feeders for average loss of 4 per cent.

No. 5 shows cost of feeders for average loss of 6 per cent.

No. 6 shows cost of feeders for average loss of 8 per cent.

No. 7 shows cost of feeders and mains for average loss of 9 per cent.

*Abstract of a paper read before the Chicago Electric Club.

No. 8 shows cost of feeders and mains in the three wire system for average loss of 6 per cent.

No. 9 shows cost of feeders and mains in the three wire system for average loss of 8 per cent.

In the three wire system curves for total cost are the lines in black just above the dotted lines.

It will be seen that if the three-wire system be operated at an average efficiency of 92 per cent. in the feeder, which corresponds to the highest efficiency claimed for the alternating current converter system, the total cost per lamp would be equal when the average length of feeder was 6,000 feet. An average length of feeder of 6,000 feet corresponds to a circular area 18,000 feet in diameter—that is, about 3½ miles in diameter. In practice, it is preferable to operate at higher efficiency, making a large investment in copper, which has the strong recommendation of having the least depreciation, and requiring the least attention of anything used in connection with the transmission of energy.

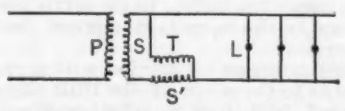


FIG. 1.—AYRTON'S SELF-REGULATING TRANSFORMER.

The middle curves represent an average efficiency of 94 per cent. in the feeder: that is, an average loss of 6 per cent. in the feeder. You will notice that even with this superior efficiency the three-wire system is cheaper per lamp than the alternating current converter system at an average length of feeder of 4,750 feet, corresponding to a circular area of 12,000 feet in diameter, and that for shorter distances the cost rapidly diminishes—the cost of conductors for three-wire system at this efficiency with an average length of feeder of 3,000 feet corresponding to a circular area 9,000 feet in diameter, being less than one-half the cost of conductors and converters for the alternating system.

Even with the very high efficiency of 96 per cent. in the feeder, or an average loss of but 4 per cent. the conductors of the three-wire system are cheaper than the conductors and converters of the alternating current converter system for an average length of feeder of 3,600 feet or less, and this corresponds to a circular area 11,000 feet in diameter.

Suppose that both the generator and converter are so much cheaper than we have assumed as above that it makes a total reduction of $1 per lamp. We then find that under conditions of equal efficiency, 82.9 per cent., the three-wire is cheaper where the average distance to lamps is one mile or less. With the usual efficiency for the three-wire system, 84.7 per cent., it is the cheaper for an average distance to lamps of 4,000 feet, or less, and with the highest efficiency, that is 86.5 per cent., with average loss of 4 per cent. in the feeders, the three-wire system would be the cheaper when the average distance to lamps is 3,000 feet or less.

Suppose, on the other hand, that the incandescent lamp be doubled in voltage, and increased 25 per cent. in economy; at the same time, that the cost of converter was reduced to two-thirds its present cost, and we find that with the highest efficiency, 96 per cent. in the feeders, the three-wire system would be the cheaper for cases where average distance to lamps is 8,000 feet or less, which corresponds to a circular district about five miles across.

Before leaving the question of economy of operation, let us look at the question of depreciation. In any dynamo the depreciation naturally becomes greater when it is operated at high E. M. F., even where the type is the same, and in the high E. M. F. alternating current generator there exists the greatest tendency toward troubles due to the breaking down of the insulation of the wire on the armature. The secondary circuit of the alternating current system and the inside wiring of the three-wire system would have a similar depreciation, but there is a great difference between the depreciation of copper conductors carrying low E. M. F. continuous currents and the depreciation of highly insulated conductors carrying a high E. M. F. alternating current, together with the depreciation on an expensive piece of apparatus like the converter, the large proportion of the cost of which is represented by labor. Try to compare the value of copper twenty years hence which costs $1,000 to-day with $1,000 of converters, and small highly insulated wire such as is used in the primary circuit of the alternating system, and I think it will be evident that the depreciation of the alternating system is going to be many times that of the three-wire system.

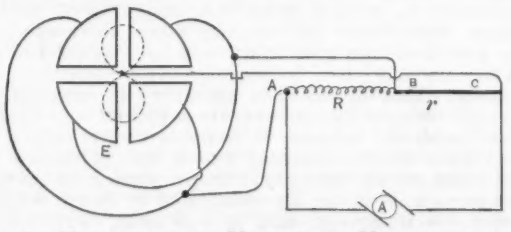


FIG. 2.—ELECTROMETER METHOD OF MEASURING ALTERNATING POTENTIALS.

Alternate Current Transformers.

In the discussion which took place on the papers of Messrs. Kapp* & Mackenzie,† read before the Society of Telegraph Engineers and Electricians, Prof. Ayrton made the following interesting remarks:

It seemed to be held by the authors of the papers read that it was impossible to use transformers *in series* if they wished to maintain constant potential difference at the terminals of the secondary when the resistance of the secondary circuit was altered; that is to say, if the number of lamps in parallel in the secondary circuit was varied. There was, however, a method of producing constant potential difference in the secondary with constant (mean alternating) current in the primary, which it appeared to him would lead to good results. The method was analogous with the compound-wound dynamo. In a compound-wound dynamo they had a series coil, which increased the magnetization of the field-magnet when the current of the outside circuit was increased. They could get exactly the same thing with transformers. Supposing the secondary coil *S*, Fig. 1, were joined in the ordinary way to the lamps *L*, let there be in addition a second induction coil *S'T*, the primary of which *S'* was in series with *S* and the secondary *T*, so joined up that it added a potential difference to the secondary circuit and added the greater potential difference the greater the current passing through the secondary. That arrangement was exactly the arrangement of a compound-wound dynamo; the tertiary coil would correspond to the series coil of the compound-wound dynamo. That was to say, a constant current passing through the primary coil *P* would produce a constant electromotive force in the secondary *S*, and a potential difference would be added to the secondary circuit, the added potential difference being the greater, the greater the current in the secondary circuit *S*. At any rate, he believed it might be possible by such an arrangement to do this, and so obtain a transformer capable of working in series.

There was only, as far as he knew, one electric method for measuring the power given to a circuit which contained self or mutual induction. The method was a method employing the quadrant electrometer. It was a method which Dr. Hopkinson employed in measuring the efficiency of Gaulard and Gibbs' transformers on the Underground Railway some few years ago. Let *A B*, Fig. 2, be the circuit possessing self or mutual induction, or both, the power given to which it is desired to measure. Place in series with this a *non-inductive* resistance *B C*, of known value, *r* ohms. and send a current through the the two by means of the dynamo *A*. Join the pairs of quadrants of an electrometer to the points *A* and *B*, and the needle to *C*; then if *A*, *B*, and *C* represent the potentials at any moment of the three points, and if *D* be the steady deflection of the electrometer

$$D = \frac{k}{2\tau}\int_0^{2\tau}(A-B)\left(C-\frac{A+B}{2}\right)dt,$$

where τ is the interval between two alternations. Next, join the needle to the point *B*, and let a steady deflection *d* of the electrometer be now obtained; then

$$d = \frac{k}{2\tau}\int_0^{2\tau}(A-B)\left(B-\frac{A+B}{2}\right)dt.$$

Consequently,

$$\frac{D-d}{rk} = \frac{1}{2\tau}\int_0^{2\tau}(A-B)\left(\frac{B-C}{r}\right)dt.$$

Now the expression on the right-hand side is the mean value of the true watts given to the circuit *A B;* therefore $\frac{D-d}{rk}$ measures this mean value of the true watts.

The use of the electrometer to measure volts only did what a Cardew voltmeter would do. The use of an electrometer to measure power, given by an alternating current to a circuit possessing self or mutual induction, did what no other instrument would do. But though the method was theoretically perfect, it had distinct practical objections. The first objection was that another resistance *B C*, Fig. 2, had to be put in series with the conductor *A B*, in which the power expended was to be measured, and, of course, a certain amount of power was wasted in this wire *B C*. That did not interfere with the accuracy of the experiment in any way, but it might be inconvenient to have to waste any power in a circuit previously worked up to its limit. But there was another more serious objection which he was not aware of up to the last couple of years. Their formula was worked out on the assumption that the ordinary law of the electrometer, as given, for example, by Clerk Maxwell was true. The law of the electrometer, as given by Clerk Maxwell, was that the deflection of the needle of an electrometer was proportional to the difference of potentials between the quadrants multiplied by a term containing the potential of the needle, minus half the sum of the potentials of the quadrants. Unfortunately, as experiments made at the Central Institution had shown, it was an exception for any given electrometer to satisfy this formula. He would not go more into that at the present time, because it would form the subject of a subsequent communication. He merely wished to warn any of them who were going to use the electrometer that, although this method was perfect on the assumption that the formula given in books was the formula for the electrometer, it naturally was not so perfect if the formula was wrong; so that even this method, pretty as it was, was at fault.

There was only one other method that he knew of by which they could measure the power and efficiency of a transformer, and that was the calorimetric method. They wanted to measure the power given to the transformer, and the power given out by the transformer. The power given out by the transformer could be easily measured. The secondary circuit would give current to, say, incandescent lamps, and as there was no lag in this part of the circuit the power could be measured merely with a voltmeter and dynamometer. But they could not employ that method to find the power given to the primary. They could, however, do it indirectly in this way: Put the transformer in a calorimeter; first put in a box, close it up water-tight, then put it in another box, which must be water-tight at the bottom, but need not be water-tight at the top; arrange a definite resistance in the secondary circuit, and send a definite current through the transformer for a certain time, and allow water to enter, say, at the bottom of the calorimeter and to flow out at the top, and measure the temperature of the entering water with a thermometer and the temperature of the water which leaves, and keep the current flowing until everything has become quite steady—until the temperature of the water as it flows out of the calorimeter ceases to rise, which in some cases took as long as three and a half hours. Then, quite apart from the specific heat of the transformer and the calorimeter, and so on, they had at once the power wasted in the transformer. Supposing *W* was the weight of water in grammes which flowed out of the calorimeter in a time of, say, *t* seconds, and suppose *T* was the difference of temperatere between the entering water and the leaving water, which he had supposed to have become quite steady, then the power in watts wasted in the transformer and given out in the form of heat was equal to *W*, the number of grammes of water, multiplied by difference of temperature *T* divided by the time in seconds *t* into a constant .239. That gave them the power in watts that was wasted in the transformer. That added, of course, to the power given out by the secondary, which was obtained by electrical measurement, gave them the power put into the primary, and they had then the whole measurement with a considerable amount of accuracy. Let him repeat, power given out by the secondary was accurately measured, provided that the secondary was attached to incandescent lamps or to something having no self-induction nor mutual induction, by the square root of the mean square of the volts multiplied by the square root of the mean square of the current; that was to say, measured by the reading of the Cardew voltmeter multiplied by the reading of the Siemens dynamometer. That was the power given out in watts. The power wasted was measured by the formula already given. The ratio of the watts obtained in secondary to the sum of the two is, of course, the efficiency. Well, that method had given them very fair results. He had compared these readings with those obtained by putting a dynamometer and a voltmeter on the primary circuit. For the interest of the thing, they had also an ordinary wattmeter in circuit, the thick coil in series with the primary and the fine coil a shunt to the mains. Now, it was interesting to see the sort of results that were obtained on the different systems of measurement, especially as they knew which results were true and which results were more or less correct. In the first case, the circuit outside was broken. That is, there was no current in the secondary circuit. This particular transformer was an exact *fac-simile* of a small transformer which Mr. Kapp had on the table last time.

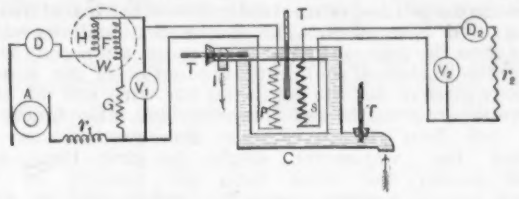


FIG. 3.

A, Dynamo; *C*, Calorimeter; *T T*, Thermometers; *P* and *S*, Primary and Secondary Coils; D_1 and V_1, Dynamometer and Voltmeter in primary circuit; D_2 and V_2, Dynamometer and Voltmeter in secondary circuit; *W*, Wattmeter, *H* being thick wire coil, *F* suspended fine wire coil of 2.16 ohms, and *G* the stationary non-inductive resistance of 895.5 ohms in series with *F*; r_1, Adjustable resistance in primary circuit; r_2, Non-inductive resistance in secondary circuit.

Primary.		Secondary.		Calorimeter.	Watts given out by secondary.	Watts given to primary.			Efficiency.		
a Volts.	*b* Amperes.	*d* Volts.	*f* Amperes	*g* Watts wasted in heat.	$h = \sqrt{d^2 \times f^2}$	$g+h$ True.	$\sqrt{a^2 \times b^2}$	*j* by Wattmeter.	$\frac{100\,h}{g \times h}$ True.	$\frac{100\,h}{\sqrt{a^2 \times b^2}}$	$\frac{100\,h}{j}$
184·3	0·8	94·5	0	53·18	0	53·18	147·2	98·5	0	0	0
184·6	2·3	96·8	3·3	79·05	318·7	397·8	424·5	446·7	80·1	75·	71·4
187·6	3·32	97·7	5·09	82·63	495·6	577·9	623·7	653·2	85·8	79·5	75·9
186·1	8·31	94·3	14·87	55·6	1416	1472	1546	1727	96·2	91·5	82
185·6	16·14	91·44	30·59	149·9	2813	2963	2995	3277	95·0	93·9	85·9

Each test given in the above table is the mean of five or six consistent results.

Efficiency $\frac{100\,h}{\sqrt{a^2 \times b^2}}$ neglects the lag due to the self and mutual induction of the transformer.

Efficiency $\frac{100\,h}{j}$ neglects the lag due to the self and mutual induction of the transformer; also the lag in the fine wire coil of the watt meter due to its self induction.

Time of an alternation in all the experiments was about $\frac{1}{140}$th of a second.

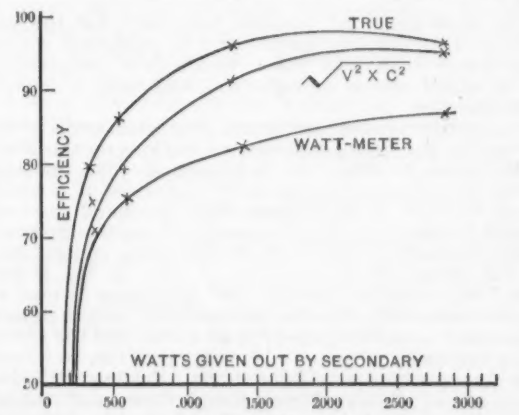


FIG. 4.

In the first case the volts at the primary circuit were 184.3, the volts at the secondary—the circuit being open—were 94.5. Now let them see the enormous differences of the power as measured in the different ways. The watts put in as measured by the voltmeter and dynamometer were 147. The watts put in measured by the wattmeter were 98.5. But the actual power put into the whole circuit was only 53 watts. Therefore the two first were enormously too large; and they could see why they were too large. They were too large because, when the secondary circuit was broken, the effective self-induction of the primary coil of the transformer was very much larger than when the secondary circuit was closed, and the errors of both methods became immensely magnified. Of course, in this case, since the secondary was open, all the power put in was wasted in the heat. But the real watts

*See the ELECT. WORLD Mar. 17.

†See page 154, this issue.

given to the primary, as determined by the calorimeter, was 53.2. The other methods indicated, then, about from two to three times too much. Of course, as the secondary circuit was closed and less and less resistance was put in, the readings given by the wattmeter as well as the product of indications of the voltmeter and dynamometer became nearly equal to the true watts, but they never, even for the maximum power, became equal. For example, when 2,963 watts were actually being given to the transformer, which was about 4 horse-power, the product of the square root of mean square of volts into square root of mean square of ampères gave 2,995 watts, while the wattmeter gave 3,277 watts as the power put into the transformer. The readings obtained from the voltmeter and the dynamometer were higher than the true watts put in, because lag, due to the self and mutual induction of the transformer was ignored altogether. The wattmeter readings were higher than the true watts put in, because, not merely was the lag due to the self and mutual induction of the transformer neglected, but the lag in the fine wire coil of the wattmeter, due to its self-induction, was also ignored. That led him to investigate the question as to whether the wattmeter ought to give them an answer nearer the truth than the product of V squared into C squared; and the result that he had obtained, approximately at any rate, was this: The wattmeter might or might not apparently give them an answer nearer or farther away from the truth than the reading from the dynamometer and the voltmeter. A rough calculation showed this was what was obtained with a wattmeter. Take a wattmeter like a Siemens wattmeter, which had practically no mutual induction, but had some self induction; then if such a wattmeter was employed to measure power in a circuit having self-induction this seemed to him what would be obtained. If r was the time of an alternation, r the resistance and L the coefficient of self induction of the fine wire circuit of the wattmeter, r' and L' the resistance and self-induction of the circuit, the power given to which it was desired to measure, then the reading of the wattmeter, compared with the true power which they wanted to measure, had this value $\frac{r}{r'} \times \frac{r^2 r r' + \pi^2 L L'}{r^2 r^2 + \pi^2 L^2}$. It was possible, by putting but a few convolutions on the suspended fine wire coil of the wattmeter, and using for the greater part of the resistance of the fine wire circuit a stationary non-inductive resistance, to make L, the co-efficient of self-induction of the fine wire circuit of the wattmeter, very small, but unless it were made absolutely nought, the term $\pi^2 L L'$ might be large in consequence of the largeness of L, and the expression would be the greater the greater L' was. So that, in other words, they might expect when the circuit the power given to which they wished to measure had very much self-induction, that the wattmeter would give an answer far too high. In the wattmeter used at the Central Institution, the self-induction of the fine wire circuit was made very small in the way just indicated, the resistance of the suspended coil having only $\frac{1}{4\frac{1}{5}}$th of the value of that of the non-inductive stationary coil, but still the watts given to the primary as measured by the wattmeter were 200 per cent. too large when the secondary circuit was open.

The accompanying table gives the results of experimental tests of a Kapp and Snell transformer. Fig. 3 shows diagramatically the arrangement of the calorimeter, and Fig. 4 illustrates graphically the different results obtained by the two methods employed, *i. e.*, the calorimeter and the wattmeter.

The Distribution of Electricity by Means of Secondary Generators or Transformers.*

BY J. K. D. MACKENZIE.

The following summary of what are now known as essential features in transformer construction may undoubtedly be ascribed to M. Gaulard:

1. The reduction to a minimum resistance of the primary and secondary circuits.

2. The obtaining of a maximum co-efficient of induction in the two circuits with a minimum in the dimensions and weight of the apparatus.

3. The placing of the primary and secondary circuits in identical positions in respect to the core or magnetic field.

4. The proportioning of the two circuits, primary and secondary, so that their metallic mass should be equal.

Given these essential features, necessary for the construction of an efficient instrument of electrical conversion it is easy to see that the mere details of construction may be varied almost *ad infinitum;* and such, it appears, is now the case.

In the earlier type of secondary generator, such as was employed in the lighting of several stations on the Metropolitan Railway during the early part of 1884, the transformers were made of a wire cable composed of a central core of No. 8 B. W. G. copper wire, insulated, and surrounded by six cables laid thereon, each containing twelve insulated strands of No. 24 B. W. G. This central No. 8 wire constituted the primary circuit, the 72 No. 24 wires forming the secondary circuit. The cable thus formed was wound round a soft iron wire core, suitable terminals being provided for connecting the primary to line and the secondary to the lamp circuits. As may, perhaps, be remembered, five stations were lighted, viz., Notting Hill Gate, Edgware Road, Gower Street, King's Cross, and Aldgate, the generating plant being placed at Edgware Road Station. The primary conducting wire was about 15 miles long, and was formed of seven strands of No. 16, the current in the primary line being about 11.3 ampères.

These generators were fitted with brass shields to the cores, by the lowering or raising of which more or less of the cable was exposed to the influence of the cores, and thus enabled lamps of various potentials to be employed from one apparatus. It was principally the desire to show how the potential of each column could be varied which induced M. Gaulard to make his transformers of a polar form, it being afterwards decided to make them non-polar only when the exigencies of actual and permanent employment of the system on a practical basis required such a change. The advantages accruing from this form were of course apparent from the first, and the matter was the subject of much discussion between M. Gaulard and myself at that time.

* Abstract of a paper read before the Soc. of Tel. Eng. and Elect., London.

As is well-known to electricians, the value of a current induced in a secondary circuit by one flowing in a primary depends principally upon the four following conditions of the primary.

1. The strength of the primary current.
2. The rapidity of the interruptions or alternations of the primary current.
3. The number of spirals which compose the circuit traversed by the primary current.
4. The number of spirals which compose the secondary circuit.

The influence of the iron core upon the secondary current is for the present neglected.

In the first condition above given, the secondary current increases as the *square* of the ampère value of the primary; and in the second it increases *directly* with the number of alternations or interruptions of the primary.

Conditions 3 and 4 affect the potential of the secondary circuit. It would hence appear advantageous to employ a large ampère primary current with a fewer number of alternations, since in the first case the generation of an induced current would be proportional to the *square* of the inducing current, and in the second case only directly proportional; but bearing in mind the formula

$$W = C^2 R,$$

C should not be greater than is consistant with practical efficiency. On the other hand, should the factor C be kept low, an increase of secondary energy would have to be obtained by increasing the number of alternations, and this might bring about loss through heating in the iron core round which the two circuits are formed in the secondary generator, and therefore it is necessary to establish a relative proportion between each of these factors.

The multiple-cable form of transformer first used by Gaulard was discarded for one in which discs of copper were employed in some cases for both primary and secondary circuits, and many of these are still in use. The great advantage that resulted from this form of conductor was that each turn of either circuit was directly upon the insulated core, and that no superimposed layers involving loss through mutual induction between the spirals were necessary.

This question of mutual induction in superimposed layers of wire, one with another, is of importance, as it is easy to see that since each wire through which an alternating current is flowing serves as a medium for inducing a current of an *opposite* direction in the one next to it, which, consequently, acts against it and against the third or succeeding one, and so on throughout the series, a loss is bound to result.

As has been before said, the value of the secondary circuit varies directly with the *square* of the current in the primary, and *directly* with the number of turns, other considerations, such as the magnetic influence of the core and the number of current alternations, being constant.

The E. M. F. of a secondary circuit, however, is dependent upon another important factor, namely, the resistance to which it is opposed.

Experimentally it was found that with a certain current in the primary circuit of a given number of spirals or turns a certain electromotive force was obtained in the secondary with a given resistance, and upon these data the construction and design of apparatus employed as series transformers were based.

The work done by the primary current when traversing a number of generators is proportional to the resistance offered by these generators, or, in other words, by the counter E. M. F. opposed to the primary current by the secondaries. This necessarily is proportional to the number in use, and also proportional to the individual resistance of each secondary.

It can therefore be seen that the total energy of the primary current varies directly with the amount of work done by the secondary circuits of the generators, thus enabling complete economy in working to be obtained.

The economy resulting from this system of working in series would be substantial were it also possible to insure constancy of potential at the same time between the poles of the secondary with a varying resistance in that circuit. The difficulty is that the E.M.F. increases in the same ratio as with the resistance; and this, consequently, points to the fact that transformers, when connected in series, must supply lamps also in series, or, in other words, the external secondary circuit must diminish in resistance as the lamps are turned out, instead of increasing, as is the case when the lamps are in parallel. More than two years ago I made some experiment upon this subject with Mr. Bernstein, the results being perfectly satisfactory so far as regulation went. Another way out of the difficulty, if series transformers and lamps in parallel are to be used, is by the employment of subsidiary resistances, or "choking coils," as they are called, which take the place of the lamps when turned off.

With series transformers and series lamps, all danger from fire risk is reduced to a minimum. No main fusible cut-out at the transformer secondary poles need be used, for, as has been before said, if a short circuit occurs, the potential immediately drops, so that the flow of current is consequently that due to the resistance of the secondary helix, including the short circuit. I have frequently run series transformers on short circuit, and no heating has resulted, the potential at the terminals being imperceptible on a voltmeter, whilst the current indicated by an ammeter in the short circuit was solely that due to the resistance of the ammeter and the secondary circuit of the transformer itself.

The author then proceed to describe the various methods and apparatus employed in alternating current distribution, with which our readers are now familiar.

Reversing Electric Motors.

To the Editor of The Electrical World:

SIR: Will reversing the direction in which a current of electricity is flowing through an electric motor also reverse the direction of the armature? In other words, will the motor when revolving from right to left be caused to revolve from left to right if the current is sent through in the opposite direction? G.

PHILADELPHIA, Pa.

ANSWER.—Generally speaking, neither a series nor a shunt-wound motor will reverse upon a change of direction in the current, as the relative polarity of field-magnet and armature remains the same. In order to reverse a motor either the current in the field or that in armature must be reversed, but not both together.—EDS. E. W.

The Bell Telephone Patents Sustained by the United States Supreme Court.

At Washington, on March 19, the United States Supreme Court, seven judges sitting, confirmed the validity of the patents granted to Prof. A. G. Bell on the telephone, by four to three.

The cases covered by the decision are six in number, one of them coming from Massachusetts, one from Pennsylvania, and four from New York. In the first five cases the appellants are Amos E. Dolbear and others; the Molecular Telephone Company, the Clay Commercial Telephone Company, the People's Telephone Company, and the Overland Telephone Company. In the sixth the Bell Telephone Company is the appellant against the Molecular Telephone Company.

The Chief Justice began his opinion with a review of the question raised as to the scope of the fifth clause of Bell's patent of March 7, 1876, that is, whether the patent was for an art or process of transmitting articulate speech or merely for an apparatus by which that object could be attained. The court is of opinion upon this point that articulate speech is one of the "vocal or other sounds" referred to in the fifth claim of the patent. Bell discovered that speech could be transmitted by gradually changing the intensity of a continuous electric current, so as to make it correspond exactly to the changes in the density of the air caused by the sound of the voice. This was his art. He then devised a way in which these changes of intensity could be made and speech actually transmitted. Thus his art was put in a condition for practical use. In doing this both discovery and invention in the popular sense of those terms were involved—discovery in finding the art and invention in devising the means of making it useful. For such discoveries and such inventions the law has given the discoverer and the inventor the right to a patent as discoverer for the useful art, process, method of doing a thing he has found, and as inventor for the means he has devised to make his discovery one of actual value. What Bell claims is the art of creating changes of intensity in a continuous current of electricity, exactly corresponding to the changes of density in the air caused by the vibrations which accompany vocal or other sounds, and of using that electrical condition thus created for sending and receiving articulate speech telegraphically. For that, among other things, his patent of 1876 was issued, and as such a patent it must, in the opinion of the court, be sustained. It is said that the claim, if given this broad construction, is virtually a claim for speech transmission by transmitting it; or, in other words, for all such doing of a thing as is probable by doing it. It is true that Bell transmits speech by transmitting it, and that long before he did so it was believed by scientists that it could be done by means of electricity if the electrical effect could be produced. Precisely how that subtle force behaves under Bell's treatment, or what form it takes, no one can tell. All we know is that he found out that by changing the intensity of a continuous current so as to make it correspond exactly with the change in the density of the air caused by sonorous vibrations, vocal and other sounds could be transmitted and heard at a distance. This was the thing to be done, and Bell discovered the way of doing it. He was the first discoverer, and with the discovery he astonished the scientific world. Prof. Henry, one of the most eminent scientists of the present century, spoke of it as "the greatest marvel hitherto achieved by the telegraph." A patent for such a discovery is not to be confined to the mere means which the discoverer improvised to prove the reality of his conception. The court is therefore of opinion that the patent must be sustained as a patent for a process or art.

The Chief Justice then considers the alleged anticipation of Bell's discovery by Philip Reis. Reis discovered how to reproduce musical tones, but he did no more. He could sing through his apparatus, but he could not talk, and from the beginning to the end he has conceded this. No one of many writers claim more than this for Reis or his discoveries. Although his first paper was published in 1861, and Bell did not appear as a worker in the same field of scientific research until nearly fifteen years afterward, no advance had been made by the use of what he had contrived, or of his method, toward the great end to be accomplished. After reviewing the history of Reis's invention, the Chief Justice says: "It is needless to quote further from the evidence on this branch of the case. It is not contended that Reis ever succeeded in actually transmitting speech, but only that his instrument was capable of it if he had only known how, and all his experiments in that direction were failures. It was left for Bell to discover that these failures were due not to bad workmanship in Reis' instruments, but to the principle which was adopted as the basis of what had to be done. Bell found that what he called the intermittent current could not be made under any circumstances to reproduce the delicate forms of the air vibrations caused by the human voice in articulate speech, but that the true way was to operate on an unbroken current by increasing and diminishing its intensity. This he called a vibratory or undulating current, not because the current was supposed to actually take that form, but because it expressed with sufficient accuracy his idea of a current which was subjected to gradual changes of intensity, exactly analogous to the changes of density in the air occasioned by its vibrations. Such was his discovery, and it was new. Reis never thought of it, and he failed to transmit speech telegraphically. Bell did and he succeeded. Under such circumstances, it is impossible to hold that what Reis did was an anticipation of the discovery of Bell."

After reviewing briefly the claims of Dr. Vander Weyde, James W. McDonough, and Cromwell F. Varley, and showing that those claims have no bearing upon the validity of Bell's patents, the Chief-Justice takes up the case of Daniel Drawbaugh of Pennsylvania, and reviews it at great length. He says the court studied with care the depositions which had been taken in such large numbers to show that Drawbaugh succeeded in using the instruments which were put in evidence as exhibits, and which antedated the instruments of Bell, and if these depositions contained all the testimony in the crse it would be more difficult to reach the conclusion that Drawbaugh's claim was not sustained. In the court's opinion, their effect has been completely overcome by the conduct of Drawbaugh, about which there is no dispute, from the time of his visit to the Centennial until he was put forward by the promoters of the People's Telephone Company, nearly four years after-

ward, to contest the claims of Bell. He was silent, so far as the general public were concerned, when, if he had really done what these witnesses now think he did, he would most certainly have spoken. There is hardly a single act of his connected with his present claim, from the time he heard before going to Philadelphia that some one else had invented a telephone which was on exhibition at the Centennial, that is not entirely inconsistent with the idea even then of a complete discovery or invention by himself, which could be put to any practical use. It is not pretended that what he did was done in private. He had influential friends with ample pecuniary resources ready to help him in bringing out his inventions when they promised success. The news of Bell's invention spread rapidly and at once, and it took only a few months to demonstrate to the world that he had achieved a brilliant success. If it were known at Eberly's Mills alone that Drawbaugh had been doing the same thing for years in his shop there—it certainly would have been known all through the little village if it had actually been done—no one can believe that the public would be kept in ignorance of it until four years afterward, when a special from Washington to the Cincinnati *Commercial* announced a telephone combination "to have entire charge of the telephones, not only in this country but in the world," that could transmit messages for almost a song. "To our minds the result of the experiments made with Drawbaugh's instruments conclusively showed that they could not have done what the witnesses supposed they did, and that what they saw and heard was produced by some other means than an electric speaking telephone. We do not doubt that Drawbaugh may have conceived the idea that speech could be transmitted to a distance by means of electricity, and that he was experimenting upon that subject, but to hold that he had discovered the art of doing it before Bell did, would be to construe testimony without regard to the ordinary laws that govern human conduct. Without pursuing the subject further, we decide that the Drawbaugh defense has not been made out."

The Chief Justice then takes up the allegations of collusion and fraud made in the charge that Bell's application as originally filed in the Patent Office did not contain his present fourth claim, or any description of his variable resistance method, and that all which now appears in the specification on that subject, including the fourth claim, was surreptitiously interpolated afterwards. So grave a charge made in so formal a manner is entitled, the Chief Justice says, to careful consideration. It involves the professional integrity and moral character of eminent attorneys, and requires us to find, from the evidence, that, after Bell swore to his application on the 20th of February, 1876, and after the application thus sworn to had been formally filed in the Patent Office, an examiner who got knowledge of the Gray caveat, put in afterward, disclosed its contents to Bell's attorneys; that they were then allowed to withdraw the application, change it so as to include Gray's variable resistance methods over Bell's signature and over the jurat, and then to return it to the files, thus materially altered as if it were the original, and all this between Feb. 14 and Feb. 19. Although much stress was laid in the argument on the fact that what purported to be a certified copy of the specification of Bell, as found in the file wrapper and entries, and as printed in the Dowd case, differed materially from the patent, the cause of these differences has been explained in the most satisfactory manner, and we entertain no doubt whatever that the specification, as now found in the patent, is precisely the same as that on which the order to issue the patent was made. If alterations were made it was all done before Feb. 19 and the fair copy, which is now found on the files of the office, is precisely as it was when the order for the patent was granted. Not a shadow of suspicion can rest on any one growing out of the misprint of the specification in the Dowd case.

The Chief Justice then reviews briefly the case of the Bell Telephone Company against the Molecular Telephone Company, which involves one of the claims of the patent issued to Bell on Jan. 30, 1877. The court below held that the fifth claim of this patent was anticipated by the Schellen magnet. Bell's patent, the court holds, was not for the magnet, but for the telephone, of which it formed only a part. To that extent the decree in that case was erroneous. It follows that the decree in each of the cases, so far as it is in favor of the Bell Company, and those claiming under it, must be affirmed, and that the decree in the Molecular case, so far as it is against the company, on the full claim of the patent of Jan. 30, 1877, must be reversed and a decree directed to that extent in its favor. It is accordingly so ordered.

Justices Bradley, Harlan and Field dissented from the decision of the majority of the court. No dissenting opinion has been prepared, but Justice Bradley stated the grounds of the dissent as follows:

"Mr. Justice Field, Mr. Justice Harlan and myself are not able to concur with the other members of the court in the result which has been reached. The point on which we dissent is the question of Drawbaugh's invention, or alleged invention. We think that Drawbaugh did anticipate the invention of Mr. Bell. We think that the evidence on that point is so overwhelming, both with regard to the number and character of the witnesses, that it cannot be overcome. Of course it is a question of fact depending upon the weight of the evidence, and involves no question of law, and therefore it is a matter that does not require much observation on the part of those who dissent from the opinion, which is very ably drawn, and presents the whole case with great force undoubtedly. But on this point we cannot concur in the views of the court. We think that Drawbaugh did have an instrument in his shop as early as 1869, which used the variable resistance instrumentality in transmitting articulate speech to a distance, and was distinctly heard and understood by means of electricity. That is the whole invention so far as variable resistance is concerned. We also think that as early as 1871 he did produce an instrument employing the magneto-electric instrumentality altogether substantially the same as that which is claimed in Mr. Bell's patent. In the one case with regard to the variable resistance principle, over 70 witnesses were produced. The evidence of some of them may have been shaken with regard to the time they had in mind; but the evidence of the great majority of them is not shaken at all. They were mostly plain people of the country, but they heard the words, and that is a matter that they could not be mistaken about. It did not require science, nor literature, nor refinement, to understand that.

"In regard to the other instrument, some 40 or 50 witnesses were produced who saw it. Many of them heard the language produced through it, and a number of witnesses who did not hear the language produced through these instruments saw them or heard them talked about so as to fix the time that they were in existence, and it seems to us that on this subject of time and of result there is such a cloud of witnesses that it is impossible not to give credence to it. There is no doubt that Mr. Bell's merits are very great in appreciating the importance of the discovery and in bringing it before the public in such a manner as to make it appear to be what it is, one of the most important discoveries of the century. He was a man whose professional experience and whose attainments enabled him to see at a glance the importance of it. Drawbaugh was a different sort of man. He did not see it. Had he done so he would have taken measures to interest persons in it with him and have brought it out. He was a mechanic, a plain mechanic, somewhat better instructed, perhaps, than most ordinary mechanics, a man of more reading, a man of more intelligence. But he looked upon what he made more as a curiosity than as a matter of speculation, a matter of financial importance, or of importance to the public. That is the way we view his condition of mind in regard to it and explain why he had not taken more pains to bring it forward to the notice of the public. It is the tendency of the human mind to attach importance to the results and inventions of those who have achieved eminence. Watt was the idol of the British nation from the time of his first invention of the steam engine until the day of his death and until the present time, and everything that was invented about the steam engine was attributed to him. The glory of Watt was the glory of England, and of course every patriotic British subject would hoot at anything it was claimed Watt did not invent, or attribute it to him. That is the principle of the human mind on which we think a great deal may be explained with regard to the feeling toward this important service which Mr. Bell has rendered with regard to this invention. The plain mechanic of Pennsylvania is of no account. The scientific and illustrious—for he is illustrious—Mr. Bell, it cannot be but that he did invent this thing. And yet if Mr. Bell, on the 14th day of January (I think it was) or February, when he applied for his patent at the Patent Office, had had in his laboratory the things that Drawbaugh had, he would have been filled with an excitement far exceeding that which has animated the great inventors of the world when they make the discoveries they have made, and he would have exclaimed, 'Eureka, Eureka.' He would have appreciated it if Drawbaugh did not. What had he when he applied for his patent? On the 10th of June, 1875, they thought they heard something, but they were not sure; but he knew the principle and he patented it. Up to the time of making his application for a patent he had not succeeded in producing intelligible speech more than a word or two, perhaps a word or two. If Bell had done at that time as much as Drawbaugh had done, according to the evidence, he would have had no hesitation in claiming the greatest discovery that the world has seen in the present century. This is an outline of the views which we have on this subject. We have nothing to say deprecatory of Mr. Bell at all, for he has real merits; but we think that this obscure mechanic did do the thing, and that he is entitled to the merit of being the first inventor. I will take an opportunity within a few days to write a further statement and file it."

The Use of the Telephone in Europe.

In his fortnightly bulletin, Gen. Barney, the secretary of the National Telephone Exchange Association, gives the following statistics:

The growth of the telephone system in Europe shows great variation in the several countries during the three years from the end of 1883 to the close of 1886. The increase in the number of telephone lines was greatest in Switzerland, where it was 1,700 per cent. (from two in 1883 to 36 in 1886); Germany, 333 per cent. (from 21 to 91); Austria, 267 per cent. (from 3 to 11); Russia, 233 per cent. (from 6 to 20); and Sweden, 200 per cent. (from 5 to 15). Belgium and Holland follow a long way behind, with an increase of only 50 per cent. (from 10 to 15). In Italy the number of telephone lines increased but 23 per cent. (from 13 to 16); in Great Britain, 19 per cent. (from 75 to 89), and in France 11 per cent. (from 18 to 20). Germany had at the close of 1886 the largest number of telephone lines, 91, and Austria the smallest, 11. The increase in subscribers has been in proportion to the growth in the number of lines. Switzerland here also heads the list, subscribers having increased by 486 per cent. (from 835 in 1883 to 4,900 in 1886). In Germany the increase was 308 per cent. (from 3,613 to 14,733); Russia, 291 per cent. (from 1,451 to 5,280); Sweden, 267 per cent. (from 1,553 to 5,705); Austria, 248 per cent. (from 870 to 3,032); Belgium and Holland, 151 per cent. (from 2,331 to 5,858), and Great Britain, 107 per cent. (from 7,287 to 15,114). France and Italy are at the bottom of the list, the increase in the number of subscribers in the former country having been only 62 per cent. (from 4,437 to 7,175, and in the latter, 52 per cent. (from 5,507 to 8,346). Great Britain still had the largest number of telephone users, 15,114, Austria the smallest, 3,030.

Telegraph Moneys Due the Government.

A suit has been begun in the United States Circuit Court by the United States Government against the Western Union Telegraph Company and the Union Pacific Railroad Company. The suit is brought to recover $12,495.45, which it is claimed is due to the government under the following circumstances:

When certain grants of land and other privileges were made by the government to the various railroads now known as the Union Pacific, it was provided that all telegraph messages for the government should be charged at a rate that should not exceed that charged to a private individual. It was further provided that all the money thus received should be paid to the United States Government, one-half of which was to be applied to the payment of interest on the bonds and the other half to form a sinking fund to take up the bonds.

The Western Union Telegraph Company built a line between Council Bluffs and Ogden, and from the year 1881 the returns of both enterprises were equally divided between the Western Union Telegraph Company and the Union Pacific Railroad. About $12,000 have been received since that time in payments by the government for telegraph work, and has been held in about equal proportions, it is contended, by the companies and not paid over to the government.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
168-177 POTTER BUILDING, NEW YORK, March 19, 1888.

The Great Storm.

The blizzard that struck New York at the beginning of last week prostrated business utterly for a day or two. No orders could get in by mail or telegraph, and owing to the state of the streets practically no goods could be delivered. By the end of the week, however, business revived wonderfully, and the activity manifested may be said to be largely due to the storm itself, the damage necessitating heavy drafts on the various supply departments.

Julien Traction Company.

Col. F. K. Hain, the well-known general manager of the elevated railroad system, has been elected a director of the Julien Electric Traction Company, in company with Judge S. A. Abbott, of Boston.

The Thone Electric Moto .

Mr. E. Bynner, of the Hawkeye Electric Company, 195 Liberty street, has ordered one of the Thone motors made by his company at Oskaloosa to be sent to the Richmond, Va., Electric Light and Power Company to be put on the circuits there for use and exhibition. I hear that other makes of motors are to be sent for the same purpose. It may not be generally known that Mr. Maurice B. Flynn, the ironwork contractor and political chief of this city, is president of the Richmond Company.

The Ball Electric Light Company.

The Ball Company are installing three hundred 2,000 c. p. lights at Fort Wayne, Ind., the lamps taking 10 ampères and 45 volts. The company has made a bid for all the lighting there at 40 cents for all night lights. The Eclipse Wind Engine Company are putting in there a number of Eclipse friction clutch pulleys. Mr. G. C. Tewksbury, the Eastern agent of the pulley, reports an active demand in the East among central stations and isolated plants.

E. P. Hampson & Co.

The Excelsior plant at the large dry goods house of Lichtensteins, in Grand street, this city, is operating with one of E. P. Hampson & Co.'s Eclipse Corliss engines, 18 by 42, of 150 h. p., running 100 arcs and 600 incandescents. Two of these engines, 14 by 30, of 75 h. p. each, have been put in the Utica Insane Asylum, operating 1,000 Edison 16 c. p. lights. One, 18 by 42, has been put in by J. F. Eifert, of 169 Attorney street, for power, and another, 12 by 30, has gone to the J. M. Horton Ice Cream Company. Mr. G. H. Morrill, Norwood, Mass., has taken one, 16 by 36.

Marine Lighting.

Mr. Alexander Thompson, the agent for marine work for the Edison United Manufacturing Company, has closed a contract with Mr. John Stetson, of the Globe Theatre, Boston, and the Fifth Avenue Theatre, New York, for a complete electric light plant for his new steam yacht, the "Sapphire." The Brotherhood three cylinder engine will be used, the engine and dynamo both being secured to the same foundation base and connected directly by means of a flexible coupling. By this means the greatest economy of weight and space is secured, making a model ship plant. The Edison United Manufacturing Company are making a specialty of these plants, to answer the requirements of steam yachts as well as all other classes of steam vessels.

A Miniature Plant.

A complete miniature Edison lighting plant is on exhibition at the Morton House Cafe, Fourteenth street and Broadway. It is shown by the W. Smith Manufacturing Company, of Providence, R. I., and consists of a model of the latest type—No. 10—Edison machine, having a pilot lamp of ⅛ c.p. on top. At one end of the exhibit is a bench with a vise, voltmeter, ammeter and pressure indicator, with a ⅛ c.p. lamp. The plant is put in motion by dropping in a nickel, which starts up a fine little model of the Hampson "Eclipse" Corliss engine. The engine is belted up to overhead shafting on which is an "Eclipse" friction clutch pulley. The details of the whole plant are wonderfully minute and exact, and the parts are gold, nickel, &c., wherever such ornamentation is possible.

Beattie Zincs.

Mr. George H. Pride has taken the New York agency for the Beattie battery zincs, which are beginning to enjoy the popularity they deserve.

Trinidad Wire.

The Callender Company reports that the Brush Company of Buffalo has adopted the new Trinidad wire for its circuits.

Cotton Leather Belting.

Mr. A. B. Laurence, 82 John street, reports having supplied a large number of steamships lately with cotton leather belting for electric light installations, including all those of the Red Star ocean steamship and Clyde lines. Orders have also been filled

for large central station and isolated plants, including that of the Edison system for the city of Yokohama, Japan.

The Hussey Re-Heater and Steam Plant Improvement Company, of 15 Cortlandt street, N. Y., are doing a general engineering and steam fitting business. They report business very brisk. They use the Hussey re-heater as a basis, and the system is meeting with success. The Hussey re-heater system is evidently a very economical one, as applied to the use of steam for power or heat, since the company states that wherever it has been applied, an average saving in fuel has been made of over 25 per cent. (including in some cases as high as from 50 to 60 per cent.). The system can be seen in operation at the Welles Building, 18 Broadway, New York, the Eagle Fire Insurance Company's building, 71 Wall street, New York, and the Central Trust Company's building, 54 Wall street, N. Y. During this month, the following orders have been filled: Watson's Paper Factory, Erie, Pa., Central Trust Company, 54 Wall street, N. Y., Bank of New York, Wall street; and a contract has just been signed by the company, to place an entire steam plant in the large apartment house at the corner of 103 street and 10th avenue, New York. Mr. Levi Hussey—a name well-known, especially in connection with Benj. Isherwood's experiments in super-heating steam at the flour mills of the late Geo. V. Hecker, some years ago—is the chief engineer of the company. Mr. Hussey is an expert in erecting and remodeling steam plants, of which this company make a specialty in connection with their system of reheating exhaust, and super-heating live steam.

They will submit plans, specifications and estimates for supplying and improving steam plants in electric light stations, and for appliances of all kinds in connection with the use of steam for power and heat in manufactories, stores, office buildings, hotels and apartment houses. The general manager of the company states that several electric light companies intend adopting the Hussey re-heater system during the coming summer.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
48 Congress Street, Boston, March 19, 1888.

Personals.

Mr. Leopold Schlegelmilch, President of the Schaefer Electric Manufacturing Company, whose serious illness and subsequent recuperation to health was reported by me some time ago, had a relapse about two weeks after leaving his sick bed, but is now out again and able to attend to business.

Mr. E. H. Hastings, formerly a resident of this city and now a member of the firm of Chadbourne & Hastings, agents for Pennsylvania, Maryland and Delaware for the Sprague Electric Railway & Motor Company, was on a short visit to the "Hub" last week looking after personal interests in this section. His firm were the promotors of the Carbondale, Pa., electric railway enterprise, this being one of the five successful electric street railway projects which Mr. Hastings' firm contracted for and equipped.

The New Armington & Sims Engine.

The Armington & Sims Company's new special double engine has been adopted by the U. S. Navy Department. The company is now building engines to attach to dynamos without the use of belts.

Electric Lights for Bucksport, Me.

The Sawyer-Man Electric Company has been awarded the contract for a plant of 250 incandescent (16 c. p.) lights for central station work at Bucksport, Me.

Electric Light News from Portsmouth, N. H.

In a communication received recently from Mr. F. S. Palmer, Manager of the Portsmouth Electric Light Company, it was stated: "That up to January last upward of 500 incandescent lights (alternating system) were being operated in his city, and that orders for additional lights of same system were coming in so rapidly that it is probable that the second 500 lighter recently purchased will be taxed to its utmost capacity by the time it was in readiness to start up." Mr. Palmer reports also as having added recently to his lights in use quite a number of arcs, and several series lamps of 65 c. p. each.

The Leicester, Mass., Electric Lights.

The town of Leicester, Mass., at its annual meeting, March 5, voted to have its town hall wired for electric lights and to light with the Thomson-Houston Company's incandescent lamps. Electricity in this town is entering freely into public as well as commercial and domestic use.

An Electric Light Plant Changes Hands.

The local electric light station of the Thomson-Houston Electric Company at Webster, Mass., passed into the hands of some of the citizens of that town recently. At the present time there are in use 30 arcs and 500 incandescent; the latter on the alternating system.

It is said that since the introduction of electric lights in Webster, gas has dropped from $3.25 to $2.25; yet the former leads both in number and in popularity.

Exhibition of Inductive Telegraphy.

There is to be an interesting exhibition of the manner in which telegraphy from moving trains is accomplished, at the United States Hotel, Boston. Mr. T. H. Knox, of the Consolidated Railway Telegraph Company, of New York, who has charge of the exhibition, very kindly sent out invitations to a large number of the electrical fraternity of this section, including the president and members of the Boston Electric Club.

W. I. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, March 17, 1888.

The Shields & Brown Company.

Owing to the rapidly increasing business of the Shields & Brown Company, manufacturers of the sectional insulated air covering for steam pipes, boilers, etc., they have recently found it necessary to move into larger quarters. During the week I called upon them at their new and commodious store, 240 and 242 Randolph street, where their new office and works are located. Through the courtesy of Mr. Shields, the resident partner, I was shown through the factory, which comprises, together with the well-arranged offices, three large floors, which are thoroughly equipped with improved machinery for the manufacture and shipping of their well known goods. Mr. Shields purposes to keep on hand a full stock of the various styles of goods and with the increased facilities for manufacturing hopes to be able to meet the wants of the trade promptly. This company has a large trade among electric light companies, having made a special study of a covering for pipes and boilers where high pressure is used. The covering is made in sections which are cut and sewed by special machinery and are shipped to the consumer direct, no skilled workmanship being required to adjust them to the pipes or boilers.

The Electrical Construction Company,

J. A. Harter manager, 171 Randolph street, has just completed the wiring of the First Presbyterian Church, at Menominee, Mich., which is to be lighted by incandescent lamps, the electric current being supplied from Electrical Accumulator Company's cells.

The Northwestern Accumulator Company.

The Northwestern Accumulator Company have just completed arrangements with the Electrical Accumulator Company, of New York, so that they are now prepared to contract for central station lighting in addition to isolated plants, which they have been pushing for some time. The work on the two passenger trains on the B., C. R. & N. R.R., which they have been equipping with the storage battery for electric lighting purposes, is completed, and, I am informed, are in successful operation. Mr. Johnson, the manager, informs me that his company are very busy just now, and the outlook for business the coming season is very promising.

The Thomson-Houston Company.

The Thomson-Houston Compaany have just sold a plant in Sioux City, Iowa, consisting of 35 arc and 650 incandescent lamps.

The Sun Electric Light Company.

The South Side Committee on Streets and Alleys granted on Monday last to the Sun Electric Light Company the right to lay wires, etc., for giving an electric light service to business houses from Adams street to 22d, between the lake and river. The company agree to furnish light to the city at actual cost and pay 2½ per cent. of the gross receipts into the city treasury.

The Mutual Electric Light Company.

The Mutual Electric Light Company submitted an ordinance to the City Council Monday night asking permission to lay wires on Division street, North avenue, Larrabee street, Claybourn avenue, Lincoln avenue, North Clark, Wells, Sedgwick and Halsted, for the purpose of furnishing light and power. The company agrees to lay the wire under the direction of the Commissioner of Public Works, and also to enter bonds of $10,000 to indemnify the city from all damages. The ordinance was referred to the Committee on Gas.

Proposed Electric Street Lighting.

Alderman Clarke has gone before the Finance Committee and endeavored to get an item from $100,000 to $150,000 inserted in the annual appropriation bill for an electric light plant for street lighting. The proposition made by him is to the effect that a plant for city lighting be established in the central portion of the city, if possible within the area bounded by Chicago avenue, Halsted street and the river, the estimate to be based on the figures recently submitted by Prof. Barrett to the City Council. From a lack of funds, it is thought that the scheme has no prospect of meeting with the approval of the committee. In the event, however, of a refusal to do anything, Alderman Clarke, it is stated, will introduce the matter in the Council.

The National Electric Construction Company,

of this city, who are the sole agents for Cook County of Applegate's burglar alarm matting, report a large number of sales during the past few weeks in all portions of the city, and including Oak Park, Hyde Park, etc. Besides the sale of the matting they also report sales of their mercurial alarm and hatch door, in addition to a large amount of electric light work which they are also doing.

Chicago Electric Development Company,

J. M. Lyon secretary, has headquarters at 225 Dearborn street. The business of the company is to promote electrical inventions, buying and selling patents and putting patented articles on the market. They report a large amount of correspondence and prospective business.

Jamestown, Dak.

H. A. Stucky, of Jamestown, Dak., called this week at the office of THE ELECTRICAL WORLD. At Jamestown, Dak., he has just completed the installation of a plant consisting of 20 arc lights of the Brush system and 650 incandescent lights of the Edison system, both operated by the same company and controlled from the same central station. Mr. Stucky reports the outlook good in Dakota for a large amount of electric light business being done the present season.

Telephone Quotations.

Col. S. G. Lynch, broker, 146 La Salle street, furnishes quotations upon telephone stock as follows:

Bell of Mo.....	$160@	$165	Iowa Union.....	$26@	$27
Central Union.....	46@	47	Michigan.....	76@	77
Chicago.....	350@	360	Missouri and Kansas	68@	69
Colorado.....	19@	21	Rocky Mountain Bell	40@	45
Cumberland.....	62@	65	Wisconsin.....	108@	109
Great Southern....	30@	32			

E. L. P.

ENGLISH NOTES.

LONDON, Feb. 29, 1888.

Discussion on Transformers.

The discussion on Mr. Kapp's and Mr. Mackenzie's papers was continued at the meeting of the Society of Telegraph Engineers on Thursday last. The chief feature of the evening was the vigorous onslaught upon the transformer system delivered by Messrs. Gordon and Crompton. Mr. Gordon's remarks were peculiarly interesting, inasmuch as he is a recent convert to the virtues of secondary batteries. He is now engaged in superintending the erection of a central station in Whitehall, which will have a capacity for ten thousand lamps. The distribution will be in simple parallel. Willans' high-speed compound engines will be used, coupled direct to Crompton dynamos, and a large number of Howell's secondary batteries are to be put in. The station will, in fact, be almost an exact reproduction of that now working at Kensington Court, of which I recently gave you some account. Mr. Gordon described himself as having hitherto posed as a champion of the alternating system and he therefore considered that his recantation should have great weight with those who still hold to the belief in the future of alternating currents, which he now abjured. But on this it may be remarked that although Mr. Gordon is certainly responsible for what was until recently the most extensive system of alternating current distribution in this country, probably in Europe, that namely at Paddington, yet the dismal failure of this installation—for a dismal failure it admittedly is—cannot be held to prove anything for or against the modern system of distribution by transformers. In fact, incredible as it may appear, Mr. Gordon positively adopted an alternating current system *without* transformers, a method which of course entails all the disadvantages under which the alternating current may labor without a single compensating advantage.

The dynamos at Paddington, which were of great size, had solid iron armature cores. As may easily be supposed, not only did they heat furiously, but it was found impossible to work them at all at any point much under full load. When Mr. Gordon refers therefore to his *experience* of alternating currents as affording the reason for his repudiation of the system, it will be seen that he has very little ground to go on. The point upon which the greatest stress was laid, however, both by Mr. Gordon and by Mr. Crompton, was the fact that from curves showing the hourly output of current taken from a central station, supplying a residential district, which were exhibited to the meeting, it was seen that in this particular case, about the hour of 7:30 P. M., the current goes up with a tremendous rush and reaches a point about twelve times larger than the mean diurnal value taken over the whole 24 hours. Moreover, if the hour from 7 to 8 P. M. be excluded and a mean be then drawn from sundown to midnight, when the greater part of the work is done, the average value for this period is not more than one-third of the value attained between the excluded hours. The explanation is that at this time all the bedrooms are occupied by people dressing for dinner, and at the same time the servants are busy in the kitchen and in the dining-room. It was therefore argued that if current is supplied direct from the machines, it would be necessary to provide engines and dynamos capable of a maximum output which would only be called upon for some half hour or an hour daily, while during the rest of the hours of lighting the engines would be working at scarcely one-third of their full power. Not merely would the capital cost be enormously increased, but as was also pointed out, in modern triple expansion, or quadruple expansion engines, the consumption of coal per horse-power is enormously greater when the engine is working so far below maximum load. As you will see the whole argument is based upon the assumption that it is not possible to connect alternating dynamos in parallel, and that it would be necessary to employ a single machine of very large size. As Mr. Crompton himself said, directly it was shown that alternating current machines could, in practice be coupled in parallel, "the bottom would be knocked out of his argument." This Mr. Mordey promptly proceeded to do, quoting two cases within his knowledge in which this was actually being done. In one case the two machines were not even in the same station, but were separated by the width of a river, and yet the parallel working had been found perfectly feasible. Mr. Mordey differed from Mr. Kapp as to the advisability of employing single substation transformers scattered at various points over the district, and connected with the various installations by an Edison network. On the contrary, he was of opinion that in wiring large buildings it would often be worth while to use several separate transformers placed on different floors. Prof. Sylvanus Thompson made a severe attack upon Mr. Mackenzie's paper, which he characterized as containing a great deal of bad science. Two or three speakers, amongst whom were Mr. Esson and Mr. Evershed, expressed a fear that Mr. Kapp's geometrical investigation, based upon the assumption that the current was a sine function of the time, was not sufficiently true to make the results of much value. Mr. Esson exhibited a diagram which was the result of calulation (not of experiment) showing what he believed to be the true shape of the curve in a modern alternating current machine containing iron in the armature. Professor Perry, who followed, explained, however, that even admitting a considerable amount of irregularity in the shape of the curve as deduced from the distribution of lines in the field, yet owing to the self-induction of the armature, there would be a tendency to smooth out the irregularities and to produce a wave much more nearly approaching the true sinusoidal form. He also described an interesting experimental method of testing the shape of the current wave. It was late when the meeting adjourned, and there were still many members who were anxious to address the assembly.

Overhead Wires in London.

The bill deposited by the United Telephone Company seeking powers to erect overhead telephone wires within an area of 12 miles from the general post-office, has called forth an opposition of a most formidable character from all parts of London and the metropolis. The time within which petitions against the bill must be deposited having expired, it is found that no less than 54 separate petitioners have lodged petitions in the private bill office of the House of Commons praying to be heard by counsel against the proposals. Among the number are the Corporation of London, the Metropolitan Board of Works, 21 of the local authorities around London, all the railway companies in the metropolis with the exception of the underground lines, 14 private corporations and all the London water companies, the latter petitioning against interference with the roads and water pipes by the erection of posts for telephonic purposes.

The Sub-Channel Cable.

Although the negotiations for the government purchase of the cables between Great Britain and the Continent of Europe are going on satisfactorily they are by no means complete; and in some quarters it is thought that there is still a possibility of the French Foreign Minister making matters unpleasant for the

British Post-Master General. This opinion, however, is not entertained by the heads of the Submarine Telegraph Company, who in fact have given up all hope of continuing its career as a private undertaking. Almost certainly the final arrangement will take the following shape: The German Union Company's cables will become the property of the German Government; the Submarine Company's cables will be under the joint ownership of the English and French governments, and the cables already belonging to the English post-office will remain its sole property as heretofore. All these cables will be maintained by England, and the laying of fresh cables will be intrusted to her, the joint purse arrangement for working the system being so adjusted as to recoup the British Government for its outlay. Notwithstanding the sentimental objections which are at the bottom of French opposition to this scheme, it will be impossible for either France or the Submarine Telegraph Company to carry on an independent opposition through the Anglo-French cables, seeing that the English and German governments will have numerous direct alternative routes which command the whole of Europe; and, in short, it may be confidently asserted, that by the beginning of next year the whole of the telegraphic communication between this country and Europe will be virtually, if not act actually, in the hands of the respective governments, and under the chief superintendence of the British post office. Mr. Raikes, the postmaster-general, is a man of determination and great force of character. He is working energetically with the treasury in this matter, and having taken it in hand he is not at all likely to let it fall through.

The House to House Electric Lighting Company.

The "house to house" electric lighting scheme, which I mentioned about a month ago, has issued its prospectus, and efforts are being made to float it as a company. The company undertakes to supply the light on a requisition from not fewer than 50 householders in any one locality. In proper hands this idea might be carried out successfully; but unfortunately it is being promoted by one whose name is associated with the worst period of electric lighting speculation, and who, more perhaps than all its shortcomings, has discredited electric lighting as a money earning business, and consequently this new venture of his is meeting with the strongest opposition at the hands of the technical press, not on its merits, but simply because he is a "suspect." His boldness, to call it by no worse a name, is however unabated. In the prospectus of the new company it is set forth that he is to receive £5,000 down, in return for which he will give his services "gratuitously" for two years. Philanthropy such as this in the early days of electric lighting speculation was very seductive, but there are indications that it has been played out, and to-day rumors are afloat that the "House to House" project is not being warmly supported.

THE TELEGRAPH.

Baltimore, Md.—The Monumental Underground Telegraph Pipe Company have asked for a city permit for laying pipes for telephone, telegraph, electric light and other wires.

Aiming at the Bucket Shops.—Mr. Cantor seeks, by bill introduced in the New York Senate, to give all associations dealing in produce, stocks, petroleum, etc., control over the publication of quotations. It is aimed at bucket shops. Senator Vedder has introduced a bill taxing bucket shops $200 per month.

Stockton, Kan., has adopted a new electric fire alarm designed by Wm. Wolcott. Our correspondent says: "It is so arranged that by touching a button fixed in a box on the bell tower a train of mechanism is set in motion that will give 450 strokes on the fire bell within two and one-half minutes: at the same time the doors of the engine house are opened and the clothing removed from the bed where Mr. Wolcott sleeps, in the rear of the engine room. It is the intention to place several boxes in different parts of the town, so that it will not be necessary to go to the engine house to sound an alarm."—*Fire and Water.*

Western Union Dividend.—At the quarterly meeting of the directors of the Western Union Telegraph Company a dividend of 1¼ per cent.—the same as for the preceding quarter—was declared, payable a month hence. The official report of earnings for the quarter (partly estimated) ending March 31 puts net earnings at $1,250,000, an increase of $500,000. The surplus, after allowing for dividend, is stated at $7,423,710, which is an increase of $645,370. Snow and sleet this winter, says the report, have caused considerable increase in the maintenance account. It will be seen, too, that the estimate makes no allowance for the loss of business by the big storm.

THE TELEPHONE.

Fort Smith, Ark.—It is said that the Arkansas Telephone Company proposes to establish a factory for making telephonic apparatus at Forth Smith.

Grafton, W. Va.—A company is to be formed by A. G. Chrislip and others to build a telephone line from Grafton to Philippi and other places.

Buenos Ayres.—A company in Buenos Ayres has recently ordered the material for a complete system of telephones from the Société Generale de Telephones at Paris. *Annales Industrielles* states that over 2,000 subscribers have been obtained, and the company proposes to erect a tower in the river, which will serve as a maritime telephone station. The harbor of Buenos Ayres is shallow, so that vessels are obliged to anchor several miles from the city. Telephone communication by means of a tower near the anchorage will be serviceable.

Buffalo, N. Y.—A special dispatch from Buffalo of March 14 says: The Bell Telephone Company in Buffalo has for some time been negotiating to settle the telephone trouble here without success. To-day it sent a letter to the People's Telephone Association here, composed of subscribers, refusing to recognize their propositions to settle and making its own terms. As a result much indignation has been caused against it. Measures will probably be taken by the association to force the company to remove its poles and wires from the business streets. The company is now under indictment for being a nuisance.

Elgin Telephone and Electrical Supply Company.—A license has been issued to W. Hubbard, A. B. Church, A. D. Sill, and R. W. Kimball, of Elgin, Ill., to take subscriptions for stock to the amount of $30,000, in shares of $10 each, for the above company. The object is the manufacture of telephones, dealing in all kinds of electrical goods, establishing and operating telephone and electric light plants. It is expected that the stock will be placed at once. It is said that the American Cushman telephone will be used where the Elgin acoustic will not serve, and that the business of one of the best electric lighting systems will be handled by the company. Mr. Hubbard is the general manager.

THE ELECTRIC LIGHT.

Canajoharie, N. Y., is agitated on the electric light question.

Brunswick, Ga.—An electric light plant is wanted by Coles, Simkins & Co.

Richmond, Va.—The Virginia Electric Light and Power Co. will install another dynamo.

El Paso, Tex.—Mr. A. W. Dutton is making arrangements to put in an incandescent station of 400 lights.

Gadsden, Ala.—Mr. W. Sanford is organizing a company to erect an electric light plant at Gadsden, Ala.

Nashville, Tenn.—Webb, Stevenson & Co. desire to put in a plant for electric lighting in their building.

Shelbyville, Tenn.—W. A. Trost, W. B. Bate and E. Sheppard will put in an electric light plant at once.

Millersburg, O.—The city council has contracted with the American Company for 20 lights of 2,000 c. p. each.

Hillsboro, Ill.—The new plant for Hillsboro is to be erected about next June, or as soon as the new water-works are finished.

Louisville, Ky.—A report has been current at Louisville that the Fort Wayne Jenney Electric Light Company intends to move to that city.

Galveston, Tex.—It is stated that the consolidation between the Galveston Gas Company and the Galveston Electric Light Company has now been carried out.

San Francisco, Cal.—It is stated that the California Electric Light Company, of San Francisco, paid twelve monthly dividends in 1887, amounting to $80,000.

New Orleans, La.—The Louisiana Electric Light and Power Company are building an addition to their station 85 by 140 feet, to make room for incandescent plant, etc.

Woodland, Cal.—The Consolidated Electric Light, Gas and Power Company has been incorporated at Woodland, Cal., by A. D. Porter and others, with a capital stock of $100,000.

Richfield Springs, N. Y.—Mr. E. Cary and Mr. W. A. Smith are interested in the movement for putting in an electric light plant at Richfield Springs, where the desire for the light is strong.

Greenville, Miss.—The Greenville Electric Light and Power Company have organized with G. E. Billingsley as president; C. M. Williams, vice-president, and H. P. Hawkins, secretary, treasurer and manager.

Winfield, Kan.—The Winfield (Kan.) Gas Company has completed its electric light plant. It is operated by an 80 horse-power boiler and a 65 horse-power Ide engine. The dynamo is a 35-light Thomson-Houston.

Lee, Mass.—A correspondent writes that Lee people talk of introducing the electric light for street and building lighting. Estimates are to be secured from the parties now putting in the Edison lights at Great Barrington, Mass.—*Manufacturer's Gazette.*

Pomeroy, O.—A proposition has been made to the city council by Mr. E. S. Trussell, the proprietor of the local *Telegraph*, to light the streets with incandescent lamps; and, if it is accepted, a plant will probably be put in at once and commercial lighting be engaged in also.

Cambridge, Mass.—The Cambridge Electric Light Company has elected the following named officers: President, J. Q. Bennett; treasurer and clerk, F. H. Raymond; superintendent, W. R. Eaton, and a board of directors. It will increase the capital stock from $60,000 to $100,000.

Nashville, Tenn.—The Nashville Light and Power Company suffered from a fire recently, but Mr. J. Wills, the superintendent, writes that all their arc lights were burning the next night as usual, although the roof was all gone and the upper story was destroyed. The incandescent circuits were also soon put in order.

Binghamton, N. Y.—The Consolidated Gas and Electric Lighting Company of Binghamton, N. Y., expects to furnish more lights the coming season, as it has made purchases of machinery that will exactly double its capacity. At least forty more electric lights are needed about the city. Only about ninety are now in use.

Babylon, L. I.—It is proposed to light the highways of Babylon, Bay Shore, Islip and the main avenue from Babylon to the South Side Club grounds at Oakdale with electricity. Mr. T. S. Carman has been over the ground and prepared the necessary plans. It is proposed to adopt towers built of iron, 125 feet high, with lights of total 12,000 candle power, each tower to illuminate a radius of a mile. The company proposes to put in a plant valued at $25,000 and guarantees to have the work done in thirty days.

An Amateur's Dynamo.—The Gardner, Mass., *News* says: "Mr. A. L. Lockwood, who is a mechanic and a genius, has recently completed an electric dynamo, which he has been working upon at odd jobs, as his time would permit, for nearly a year. The work upon the machine, with the exception of the castings, was all done by Mr. Lockwood, and the only drawback to his enjoyment with the contrivance is the fact that his engine is not large enough to run the thing to its full capacity, which good judges say is equal to eight lights. As it is, he is able to run three arc lights of 2,000 c. p. quite handily, which illuminates his machine shop in a very satisfactory manner."

APPLICATIONS OF POWER.

Baltimore, Md.—A bill has been introduced in the legislature at Annapolis authorizing the Powhatan Railway Company to use electric motors.

Buffalo, N. Y.—A demonstration was given at Buffalo last week of the Elieson electric motor car, by Mr. Morton, who represents the system in America.

Wichita, Kan.—The Riverside Motor Line Company, of Wichita, Kan., has contracted with the Sprague Electric Power Company, of New York, for an electric railway two miles in length.

Electric Motor Watches.—An exchange says: A company has been formed in Berlin to manufacture electrical watches. Two small cells and a small electric motor take the place of the ordinary watch movement.

Batesville, Ark.—The Batesville Street Railway Company has been organized by A. A. Webber and others, and will build a road 1¾ miles long to begin with. It has still to decide whether it will use mules or electricity as motive power.

Hot Springs, Ark.—The Happy Hollow Street Railroad Company has been organized at Hot Springs, by E. W. Rector, H. M. Rector, Jr., G. Miller and others, with a capital stock of $50,000. It is privileged to use electric motors if desired, and will shortly begin operations.

Lander, Wyoming.—It is proposed to erect a roller process flouring mill at Lander, Wyo., to be run by electricity, and it is reported that negotiations are pending for its construction by the company which put up the mill at Laramie City, Wyo., which is being run by an electric motor.

Wilmington, Del.—A telegram from Wilmington of March 10 says: The first accident of importance on the Wilmington new electric railway happened this evening. A team driven by a drunken man collided with an approaching car, and the horse was instantly killed. A passenger in his efforts to ward off the oncoming team put his elbow through one of the car windows and a piece of glass flying into the car gashed the throat of a boy so badly that his condition is considered dangerous.

PERSONALS.

Mr. R. H. Sterling, the electrician, of the Colorado Electric Company, of Denver, was in New York last week and a caller at this office.

Mr. Theodore N. Vail is one of the incorporators of the Twenty-third Ward Bank of the city of New York, just organized, with a capital of $100,000, which may be increased to $500,000.

Mr. F. H. Robinson, the superintendent of the Bangor Electric Light and Power Company, is being congratulated upon the stability and prosperity of the plant which under his management is now paying 6 per cent. dividends.

Mr. E. A. Leslie, formerly general superintendent of the Baltimore & Ohio Telegraph Company, and latterly general manager of the New York Isolated Accumulator Company, has accepted the general managership of the Consolidated Subway Company, of New York.

Mr. H. P. Copeland, the purchasing agent and contract clerk of the Metropolitan Telephone Company is, we are sorry to say, compelled by ill-health to resign his position. The resignation will take effect as soon as his successor, Mr. M. C. Dodd, is ready to assume the duties of the office.

Gen. Thomas Sherwin, president of the New England Telephone Company, being interviewed as to the proposed exclusive franchise in Boston to construct and own electrical conduits for twenty years, says that such a power has never been granted by the city of Boston, and for the public good it never should be.

Mr. Wilfrid H. Fleming, who has recently completed a large isolated installation at Decatur, Ala., for the Sawyer Man Company, is North for a brief stay. Mr. Fleming reports the Southern outlook as excellent, and as the outcome of the good work done on the present plant, he has a number of negotiations in hand for new contracts.

Capt. J. V. Meigs delivered a lecture at Boston on Feb. 29 upon the system known by his name, and devised by him for rapid transit purposes. As our readers are aware, he uses a one-rail elevated track. In the course of his lecture he said: "My tracks are peculiarly adapted to the use of electricity, and I should welcome an electric motor of sufficient power to be practical."

Mr. H. E. W. Palmer, has been appointed to the charge of the Southern agency just established at Atlanta, Ga., by the Thomson-Houston Electric Company. Mr. Palmer was formerly private secretary to Governor McDaniel, of Georgia, during that gentleman's administration, and has a large acquaintance throughout the State. This selection is regarded as another evidence of the company's success in securing good representatives.

M. Lucien Gaulard.—It appears that the unfortunate victim of hallucinations who called recently at the Elysée, and announced himself as the Supreme Deity, is a M. Lucien Gaulard, electrician, and the inventor of the well-known generators which bear his name. For his demonstration of the possibility of practically applying the principle of the transformation of the electric current to the distribution of light by central stations M. Gaulard received the *prix d'honneur* of 10,000 lires at the Turin Exhibition of 1884, as well as the grade of Chevalier in the Order of Saints Maurice and Lazare.—*Galignani Messenger.*

MISCELLANEOUS NOTES.

The Electric Death Bill was made a special order in the New York Assembly for March 21.

Montreal, Can.—The Board of Trade has recommended that the City Council adopt subways for all the wires.

The Board of Electrical Control.—The Attorney General has decided that the officers of the New York Board of Electrical Control are State servants, and that applicants for positions under it must be examined under civil service rules.

Electrical Execution.—At a meeting of the Medico-Legal Society, a committee comprising R. O. Doremus, Clark Bell, J. M. Bleyer, C. F. Stillman and I. H. Ingram reported in favor of execution by electricity, as recommended by the State Commission.

The Submarine Monitor Not Sold.—The Submarine Monitor Company, of 10 West Twenty-third street, is in the hands of the sheriff. C. D. Shepard, who advanced considerable money to the company, obtained a judgment against it for $9,127. It was incorporated March 24, 1884, with an authorized capital stock of $5,000,000, which was paid for the patents. M. Roosevelt Schuyler was the President. The submarine monitor is at the foot of West Thirteenth street. The sheriff's sale was to have taken place last week of the boat, models, office furniture, etc., but it was postponed, as the parties in interest, it is said, were snow-bound.

At the Ticket Seller's Elbow.—An electrician has invented a device to prevent counterfeiting of railroad tickets, and at the same time keep a strict watch over the ticket sellers. It is being examined by the officials of several roads with a view to adoption. The ticket agent prints the ticket himself. In front of him would be a little machine, connected with a battery, through which a roll of paper would pass. By touching a key the ticket would be printed and shoved forward, where a knife would cut it off the roll and it would fall down in front of the passenger. When the ticket agent touched the key an electric impulse would move an indicator on a dial in the company's office, recording the number of the ticket or amount collected. For instance, the first ticket sold would indicate the figure 5, the second 10, and so on, so that at all times the superintendent would know just how many fares had been received at each station. To prevent counterfeiting, the tickets are printed so that in a few moments they will fade away into nothing but a strip of dirty white paper.

Running Accumulators by Rainfall.—It has occurred to a gentleman resident in Georgetown, West Indies, that a possibly valuable source of energy is allowed to run to waste in the tropics in the shape of the water which pours off the roofs of the houses whenever there is a shower. The gentleman in question, in a lecture delivered recently before a local society, said that, "having been frequently struck by the great volume of water discharged from the roofs during heavy tropical rains, it occurred to me that the power so wasted might be utilized some way by converting it into electricity by the following means: The water from each roof might be conducted into one main down pipe, in which would work a small turbine wheel driving a dynamo-electric machine, the electricity so developed by every passing shower to be stored in accumulators of the type of Faure's secondary batteries. These, as they became charged in variable time, depending on the rainfall, could be collected and stored at central depots, from whence the power could afterward be distributed uniformly, either by electro dynamic engines, or utilized directly for electric lighting."

BUSINESS NOTICES.

Frames of every description for show-cards and pictures can be had of William Levin, 37 Dey st. Quality and promptness guaranteed. Catalogue and estimates on application. A full line of elegant pictures low, for cash.

Jordan & Gottfried, 208 Canal St., N. Y., carry a complete stock of iron and brass machine and wood screws, bolt cap and set screws, taps, dies, files, twist drills, brass and rubber tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

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OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

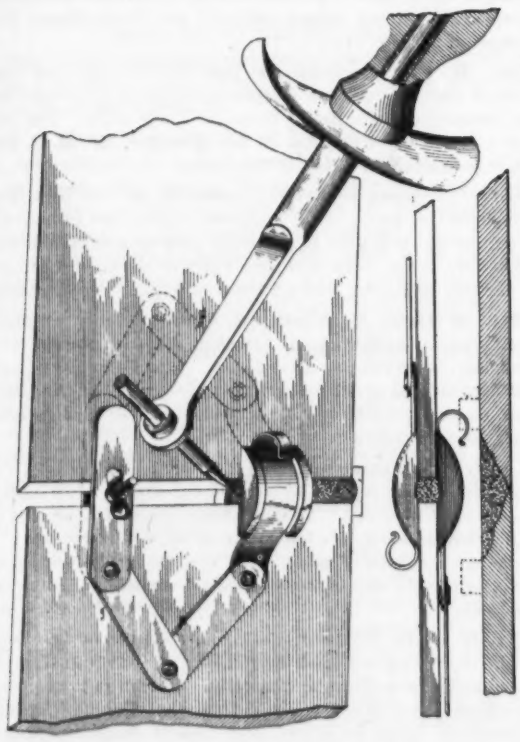
PATENTS DATED MARCH 6, 1888.

378,913. Supporting Crane for Electric Lamps; Leander J. Wing, Lexington, Mass. Application filed May 3, 1887. At the top of the pole a metallic head is fixed which supports two lateral arms, one of which carries a weight to balance the lamp carried by the other. The arms are tubular and the cord by which the lamp is raised and lowered passes throuh gthe tubes.

379,082. Slot Switch for Electrical and Cable Railways; Sidney H. Short, Denver, Colo., Assignor by direct and mesne assignments to the United States Electric Co., of same place. Application filed March 24, 1887. A printed plate of V-shape is placed at the switch. It is held normally closed by a spring and may be moved by the brush arm or other projection coming in contact with an inclined edge on the plate.

PATENTS DATED MARCH 13, 1888

379,221. Coupling for Joining Electric Wires Carl Hering, Philadelphia, Pa. Application filed Dec. 5, 1887. A coupling for joining wires, consisting of a piece of metal bent so as to form two loops, with an intervening connection



379,453. WORKING METALS BY ELECTRICITY.

between the loops composed of two or more thicknesses of metal juxtaposed in the tangent of the loops. The ends of the wires are held in the loops.

379,255. Incandescent Lamp-Socket; F. Thone, Oskaloosa, Iowa. Application filed Feb. 16, 1887. A laterally extending slide bar passes through the socket. It carries an insulated conducting block which, when the slide is moved, either cuts the lamp in or out.

379,284. Dynamo-Electric Machine; Lewis C. Rice, Denver, Col. Application filed July 1, 1887. The invention consists in making both the field-magnet and the armature in a ring form, with Pacinotti projections from the core between the bobbins. These rings are placed one within the other, the inside one having external projections and the outside one having corresponding internal projections. The rings are made up of annular discs with spacing for ventilation. The ventilating spaces in the field-magnet and armature, respectively, are radially in line with each other, so that a current of air can pass from the centre outward through both. Either the internal or the external ring can be held stationary, while the other is made to rotate in the usual manner. Both rings are wound with the same number of bobbins, which are connected in a closed series, as in the ordinary Gramme or Pacinotti winding. The bobbins of one ring are connected to the ordinary commutator or collector, upon which bear the usual sliding brushes, while the bobbins of the other ring are similarly connected to a stationary series of contact-points, and switches are made to bear upon these points, so that the connection may be varied at will and the magnetism of the ring correspondingly shifted. See illustration.

379,368. Telegraphic Pen; Herschel P. Copeland, East Orange, N. J. Application filed Dec. 29, 1887. For description see page 151, this issue.

379,372. Non-Polarizing Constant Current Battery; Frank J. Crouch, Eugene City, Oregon. Application filed June 11, 1887. A leaden coil is connected with one binding screw and a zinc plate with the other. The two are separated and surrounded by sand and both lie above a body of sulphate

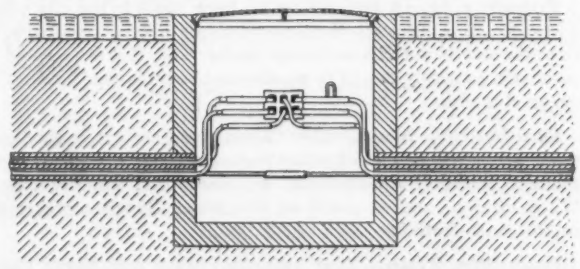
379,535. TELEGRAPH WIRE.

of copper which is placed in the bottom of the jar. A perforated concaved plaster of paris cover fits over the jar.

379,396. Electric Gas-Lighter and Extinguisher; George L. Hogan, Olmstead, Assignor to himself, and Berry T. Conway and James A. Kelly, both of Lebanon, Ky. Application filed July 2, 1887. A gas-burner provided with a puppet valve operated by a shaft and eccentric receiving rotary motion from the oscillating armature of an electro-magnet, the mechanism being adapted to alternately open and close the gas supply.

379,329. Fire Alarm Signal-Box; George M. Stevens, Cambridge, Mass. Application filed July 14, 1887. The pull lever carries a pawl which engages with a notch in a detent wheel. A shield or guard lever is arranged to alternately cover and uncover the detent notch in the wheel and allow the pawl to operate.

379,404. Device for Returning Signals in District Telegraph Systems; W. V. Lockwood, Waterbury, Conn., Assignor of one-half to G. S. Parsons, same place. Applica-



379,532. TEST CIRCUIT AND APPARATUS FOR ELECTRICAL CABLES.

tion filed July 18, 1887. By closing a circuit through a series of contacts at the central station a clockwork is released and sends a return signal to sub-station to inform the one signaling that his call has been received.

379,408. Underground Conduit; M. Richards Muckle, Jr., Philadelphia, Pa. Application filed Nov. 25, 1887. A novel form of car for conveying the cables through the conduit runs on suitable ledges on the interior of the same.

379,453. Working Metals by Electricity; N. De Benardos, St. Petersburg, Russia. Application filed Dec. 28, 1887. The improvement in the art of joining metals by means of the directly applied electric current, which consists in forming a pocket between the edges of the pieces of metal to be joined together, placing metallic scraps or pieces therein, and then melting or fusing the scraps by means of the voltaic arc formed by a conductor approached thereto, which constitutes one pole, while the metal itself constitutes the other pole. See illustration and also THE ELECTRICAL WORLD, Feb. 25, 1888.

379,459. Bell Cord for Cars; W. Glasgow and S. S. Stevens, Chicago, Ill., Assignors to the Combined Electric and Trip Bell Cord Company. Application filed May 18, 1886. A cable consisting of a number of insulated wires, connections between which may be made by operating a device on the cable itself. The cord is used as a mechanical pull as well as the circuits of different electric bells.

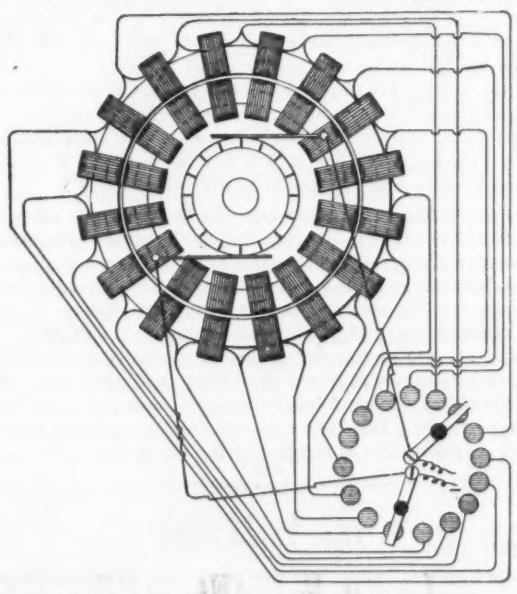
(1) 379,466. (2) 379,467. Regulators for Electric Motors; Daniel Higham, Philadelphia, Pa., Assignor to the Higham Electric Motor Company, of same place. Application filed June 29, 1887. In both cases the faces of the pole pieces are laminated transversely to the direction of rotation of the armature, and in the former case main coils are placed on the cores and distorting coils on the pole pieces, while in the latter case both sets of coils are placed on the cores.

379,501. Switch for Electric Light and Motor Circuits; Frederick W. Brann and G. Irving Kinney, of San Francisco, Cal. Application filed Nov. 14, 1887. A suitable box or case having binding posts on the outside for connecting the wires of the main or service circuit, and of the branch or line to be controlled; a switch-lever connected by conductors on the inside with the binding posts of one set of wires and contact points connected with the other set of binding posts by other conductors.

379,509. Electric Surface Railway; John A. Enos, Boston, Assignor to himself, William C. Otis, of Nahant; E. Herbert Ingalls, and Paul West, both of Brookline, and William E. Plummer, of Newton, Massachusetts. Application filed April 15, 1887. The current collector consists of an upright hinged frame on top of the car carrying brushes. The brushes normally lie against the overhead conductors, but may be pulled out of contact by means of a cord which is under the control of the engineer.

379,511. Machine for Regulating Time-Pieces. Wm. B. Farrar, Greensborough, N. C. Application filed Nov. 2, 1887. A watch may be automatically regulated by connecting it with a regulating clock having an arm supporting an adjustable needle, which operates a circuit breaker. An electro-magnet and gearing are connected to the regulator of the watch. The regulator of the watch is moved every time the main clock closes the circuit.

379,532. Test Circuit and Apparatus for Electrical Cables; I. H. Farnham, Malden, Assignor to the New England Telephone and Telegraph Company, Boston, Mass. Application filed Nov. 26, 1887. Means for breaking the circuit of an inaccessible conductor, which contists of a non-magnetic



379,284. DYNAMO-ELECTRIC MACHINE.

case or tube inclosing the two ends of the conductor, and a movable iron contact piece normally connecting the ends of the conductor, and thereby maintaining continuity between them, but adjusted to respond to magnetic attraction applied at the exterior of the case and thereupon to disconnect the conductor ends from one another. See illustration.

379,535. Telegraph Wire; William Hewitt, Chambersburg, New Jersey. Application filed Sept. 10, 1887. The invention relates to electric conductors composed in part of copper and in part of steel, and it comprehends a conductor composed of galvanized copper wires combined with steel wires galvanized or ungalvanized at will. See illustration.

(1) 379,551. (2) 379,552. Primary Electric Batteries; Henry Woodward, Detroit, Mich., Assignor by mesne assignments to the Woodward Electric Co. of same place. Applications filed Oct. 7, 1887. (1) The negative electrode is composed of a piece of iron placed in a perforated iron jacket and surrounded by oxide of copper and iron filings. The positive electrode is composed of sponge zinc, and both are immersed in a solution of caustic potash. (2) A porous cup carries a number of connected zinc plates immersed in caustic potash. The outer jar is filled with broken carbon in which is placed a carbon plate, and the whole immersed in chromic acid.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had from this office for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, New York.